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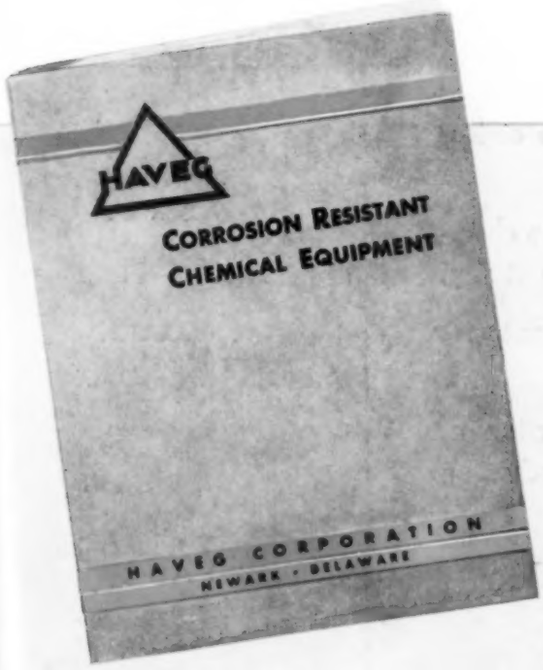

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ENGINEERING

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S. D. KIRKPATRICK, Editor

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THAT RESEARCH BUDGET

THIS MONTH we must fight the Battle of the Budget. There have already been a few preliminary skirmishes along the line, one or two brilliant advances and also, unhappy to relate, some sectors have fallen back in orderly retreat or have been routed completely. Now, however, the forces must be mustered again for the decisive struggle. Every research director, if he is deserving of his command, knows that this year he is fighting against heavy odds and that only with the best of strategy can he hope to attain a clear-cut victory. It behooves him to study not only his opponents but also those allies whose support will count for most in the battle ahead.

Perhaps the strongest of these allies are the sales forces and (though it may shock someone's dignity if we say it), the advertising and publicity departments. There is no getting around the fact that research has been most successful on the occasions where this liaison has been closely maintained. And this is as it should be, for research is the intelligence division of our industrial army and its findings are most useful to those who are to carry the attack into new territory—to break down the sales resistance of opposing forces.

Forgetting the military metaphor for the moment, we feel that this is the time when careful thinking and planning are in order if research is to continue on the present desirable scale. It is not a time when we can talk too much about the conquests of pure science and the great background of fundamental study. There are few sales managers who know how to convert them into profits for the 1933 balance sheet. The work to be done is with things that can be sold.

This means that the research viewpoint must be that of the customer whose problems in the use of your product are as much yours as his. If he is as infallible as the department store's slogan would have us believe, we can well afford to point our research in the direction of his wants. If he is wrong, we can help him to find a better product or a better way. The most practical research in the world is that which discovers the need, develops the product to meet the need and then helps to sell the new development and to see that it stays sold.

A word about salaries may not be amiss in our discussion of next year's research budget. We have heard recently of one or two incidents in which chemical firms have discharged seasoned employees to take on unemployed men of equal experience but who have been forced by circumstances to work for whatever they can get. It should be obvious, of course, that this temporary advantage will be lost just as soon as the men can find positions that will pay them commensurate salaries. And with them will go a certain amount of valuable information as well as investment in their training and experience. Isn't it better to fight the battle through with your own personnel, schooled in your methods and willing to carry on, if necessary, even at a temporary sacrifice in salary or position?

The Battle of the Budget will not be any battle at all if those in control of the purse-strings are convinced in advance that research is going to pay dividends in new products and more sales of old products. It can and will do this if research men will join forces with the rest of the organization in budgeting for greater return on dollars spent in 1933.

EDITORIALS

What of 1933?

BARRING developments now unforeseen, the first quarter of the new year should show some slight seasonal improvement in chemical industries. Then as reconstruction continues there should be increased employment reflected in greater purchasing power and higher commodity prices. Deflation, it would seem to us, must be just about as complete as it can be without total collapse of the whole industrial structure. Therefore, the one direction left to go is upward, and our guess is that business will start, perhaps slowly but nevertheless definitely, in that direction early in 1933.

Patent Problems In Chemical Engineering

OWNERSHIP of intellectual property, a subject of much concern to chemical engineers, was thoroughly considered at one of the technical sessions of the American Institute of Chemical Engineers in Washington. That discussion brought out the tremendous importance to our profession of a clear understanding as to the ownership of the results of research whether it be done under governmental, academic, endowed, or private auspices. This matter concerns chemical engineers professionally in a very personal way because many of us rightly desire to profit from the products of our mental effort when this takes the form of invention. Our interest also extends to the inventions made by others which are also of concern to our industrial employers.

Chem. & Met. has long taken the stand that the ownership and control of patentable invention resulting from government expenditure should be clearly defined. At the present time despite any of the court decisions there is great ambiguity in the law. Apparently almost every one recognizes this uncertainty, save Congress. We believe that correction of the present legal uncertainty should be made and that all parties of interest should join in impressing Congress with the importance of such legislation.

There are two schools of thought involved. One group believes that the government investigator should have the right of personal profit from the commercial exploiting of the results of his inventive genius. Quite a contrary opinion is held by many others who believe that the results of government research, when invention results, should belong to the public because public funds have been used to secure these results. (When educational institutions are endowed and quasi-public agencies are involved, the question is less sharply defined but nonethe-less real and important.)

Chem. & Met. holds that there should be no uncertainty with respect to the ownership of inventions resulting from the research done in government laboratories no matter whether it is wholly or only partly financed with tax money. We are thoroughly convinced that such inventions should belong to the public. They are no more rightfully the property of the individual than are the patents which come to the investigator engaged as a research man by an individual corporation. The public is the employer of these government men and the public should profit, not the individual. If salaries are inadequate they should be made ample by other direct means, not by the indirect scheme of attempting to give profit from inventions to the individual government investigator.

The meeting in Washington was advised that a new law bearing on this question has been drafted and is to be submitted to Congress shortly through the Chief Coordinator of the Budget Bureau. We were told, quite unofficially, that this bill gives still further rights of private exploitation to individual government workers. If the bill tends to clarify the law we are to that extent in favor of having it presented and considered. But we are unalterably opposed to any such scheme of subsidizing the individual worker by the uncertain and highly dangerous plan of giving him personal profit other than his salary from work done as an employee of the government.

This is only one of the many patent questions to which our profession must give diligent study and on which we must all be prepared to act with vigor and promptness in order to advance the cause of a better patent law of broad public value.

Canada May Come to A Bargaining Tariff

WITH THE exception of the Irish Free State, British India, and Newfoundland, all the British possessions which were represented at the Imperial Economic Conference held at Ottawa last August have officially ratified the proposals agreed upon at the conference. In its briefest aspect the purpose of the conference, and the agreements growing out of it, was to increase trade among the various divisions of the British Empire by replacing with Empire products many products formerly obtained from non-Empire sources. Reductions of duties on goods shipped in inter-Empire trade, increased duties on outside goods, and control of imports by the establishment of quotas form the media by which preferences to Empire products are to be made effective.

Plans for expanding British trade in chemicals and related products consist mainly in setting up preferential duties on imports into Canada whereby United Kingdom manufacturers are given an advantage in supplying the Dominion market with chemicals and dyes hitherto furnished largely by the United States and Germany. If foreign trade could be regulated solely by legislative enactments the outcome of preferential trade agreements between Canada and the United Kingdom would be detrimental to the industry of this country. In 1931 Canada received 19 per cent of the chemicals exported from the United States. Latest available export data show that this ratio was being maintained in the present

year. The new set-up undoubtedly will cut down our chemical trade with Canada but the extent of decline may be held to narrow limits because of advantages in supply of raw materials, of proximity to consuming markets, and of long-continued contacts which are appreciative of service and quality of product.

Provision is made in the agreements between the United Kingdom and the Dominions that, in the event of circumstances arising which are judged to necessitate a variation in the terms of the agreements, the proposal to vary those terms shall form the subject of consultation between the respective governments. This clause gives significance to the fact that tariff tribunals are being set up in the different countries. Possibly these bodies will be empowered to treat on tariff matters with non-Empire countries. When the Canadian tariff commission begins to function it may be found advisable to open trade negotiations in the United States. In that direction lies the possible path toward an equitable settlement of some of the difficulties American chemical companies are already beginning to experience.

Barter as A Last Resort

THAT PROPOSAL that we swap Farm Board wheat for Chile's surplus nitrates continues to bob up with such frequency as to suggest that some organized agency is behind it. Perhaps it is only the counsel of desperation on the part of the Chilean government in considering its unprofitable excursion into the ownership of the natural nitrate industry. Perhaps American banks and others with dollars invested in this same enterprise have quietly helped to support this promotion. The fact remains, however, that months ago the whole scheme was thoroughly investigated and shown to be unnecessary and impractical.

But now comes the proposal on a more ambitious basis that as part payment on war debts we accept $100,000,000 worth of such strategic raw materials as manganese, chromium, tin, rubber, nickel, mercury, tungsten, mica and coconut shell carbon. The idea is that the United States would agree to take these stocks off the market by storing them for use only in the event of a national emergency. It is claimed that this would stimulate the price of new production and restore purchasing power in the countries of origin. All of these arguments, it seems to us, have a faintly familiar sound. Was it not for some such reason that we got into the Farm Board business, and was not also there a War Minerals Board that tried to play hide-and-seek with the laws of supply and demand some fifteen years ago?

Our feeling is that this country is still a long way from descending to barter. It is indeed a sad commentary on international exchange when we must collect our debts in commodities we do not need and whose storage in this country would handicap our recovery in order to promote that of our debtors.

Silver Anniversary Of Chemical Engineering

EARLIER this month the American Institute of Chemical Engineers held its twenty-fifth annual meeting in Washington and celebrated, perhaps prematurely by a few months, the silver anniversary of organized chemical engineering in America. This pleasant occasion afforded an appropriate opportunity to look back on the growth and achievement of our profession, and on such a basis to look forward to greater usefulness to industry and to the public.

In the quarter of a century since the Institute was founded in Philadelphia, many of the fondest hopes of its sponsors have been fulfilled. Chemical engineering has come to be recognized as one of the five major divisions of engineering. That recent and inspiring booklet of the Engineering Foundation entitled "Engineering—A Career—A Culture" so defines the field of engineering. The Society for the Promotion of Engineering Education has publicly lauded the chemical engineers for their pioneer work in cooperating with schools and universities in which chemical engineering is taught. This, incidentally, was one of the first objective outlined by the founders of the Institute and has been a work in which the organization has had a continued and sustained interest.

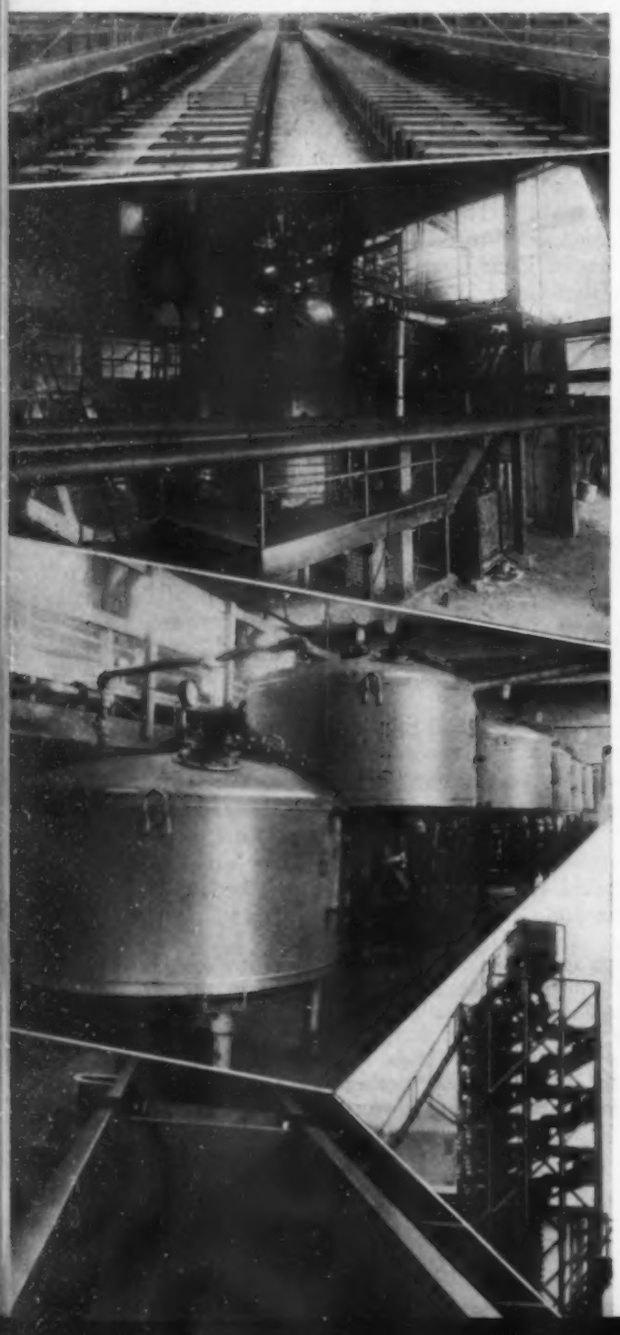
The building of a literature of chemical engineering in this country is, in itself, an important achievement. Despite the fact that German universities were the first to provide special training of engineers for the chemical industries, we find a growing use even there of American books and periodicals. A recent translation of a popular American text pays a high compliment to our literature, and at the same time brings out a significant difference in the status of chemical engineering education in the two countries. It is apparent that emphasis there is still largely placed on a purely descriptive knowledge of equipment rather than on the quantitative concept of principles that underly chemical engineering.

But the meeting at Washington was not entirely an occasion for boasting and self-congratulation. There is a future to consider that carries with it new problems and responsibilities. It is significant that both graduate and under-graduate registration in chemical engineering has resisted the downward trend that has become plainly evident in the older branches of engineering. These youngsters have chosen their careers in anticipation of the continued growth and progress that has characterized the profession in the past three decades. Our own future is tied up in theirs and we must carry on—as the late Dr. Charles F. McKenna said so prophetically at the meeting on June 22, 1908, in Philadelphia:

> . . . . . we begin as brothers. We inevitably will close our careers as fathers, passing on to our sons in the profession a heritage of knowledge and light that shall increase as the flame increases with the fuel. No man who works for the success of this society works for himself. He can expect no reward other than the pleasure which comes from fostering a worthy cause . . . .

By HUGH MILLER
Chemical Engineer
Formerly with National Aniline and Chemical Co.
Buffalo, N. Y.

Eliminating Guesswork in MATERIALS of



TO THE superficial observer it seemed to require a great deal of courage when John A. Roebling, in 1883, designed a suspension bridge across the East River, with a span greater than had ever before been attempted, and with no other guide than his own empirical formulas. Again, only a few years ago, railroad executives imagined themselves as being quite courageous when they first started to transport nitric acid in tank cars of alloy steel. Yet Roebling was just as confident of success as were the engineers who conceived and carried on the present system of acid transportation. The study of corrosion is still in its infancy, but we have reasonably safe methods of selecting materials for chemical equipment, even where no precedent has yet been established. No excuse exists for the engineer who is afraid to use new materials because he prefers playing safe with present equipment—even though unsatisfactory, rather than making use of a material which promises to be an improvement, but which, on account of uncertain methods of testing, he is unwilling to recommend. The millennium in chemical equipment is far from being reached; this is especially true in regard to corrosion. The engineer is consequently always on the look-out for materials of greater resistance to this action.

As all process industry equipment corrodes or deteriorates, the question at once arises—when is a material not satisfactory for the process in which it is being used? Naturally it is not satisfactory if another material can be substituted which will reduce the cost of the product. The efficiency of equipment is most easily determined by careful scrutiny of the detailed maintenance and depreciation items on the cost sheets, which are generally kept in detail for each product manufactured. However, this is sometimes difficult, as for example, in the dye industry, where the same equipment "setup" is frequently used for as many as half a dozen products; when a replacement or repair is necessary, the different products involved must be given their proportional share of the cost. The same rule applies when allocating depreciation costs on equipment used for more than one product.

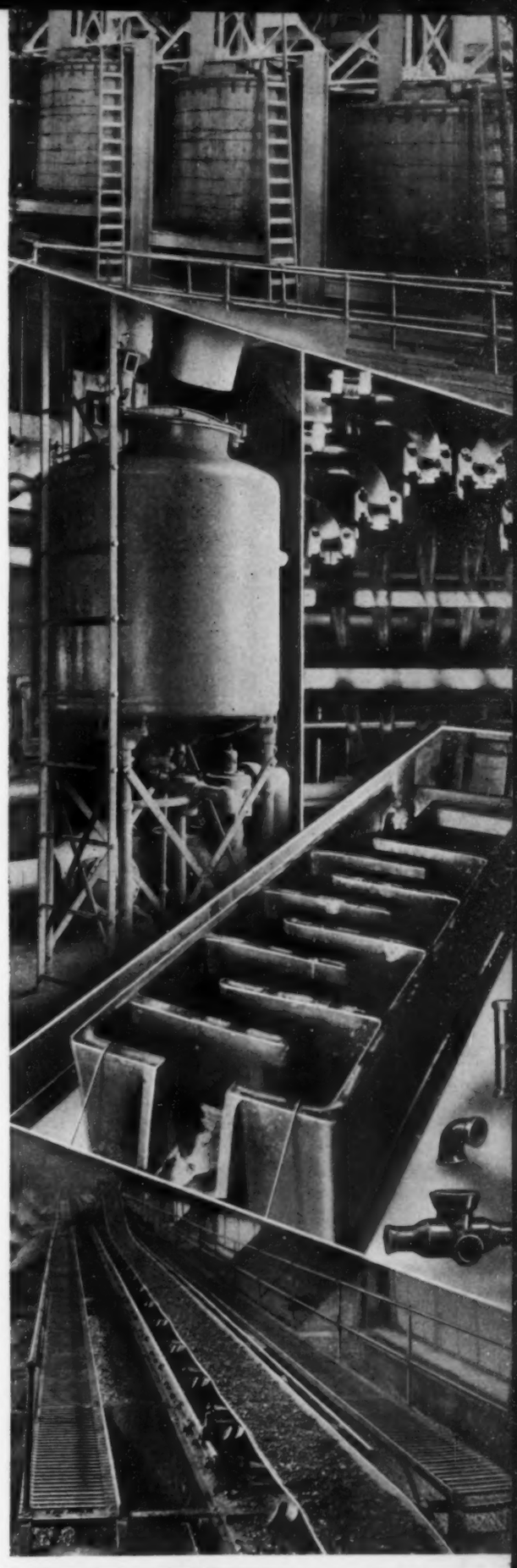
The engineer has available the exact amount of money spent over a period of months or years on any one piece of equipment; and by the records of the nature of repairs, he can determine whether failure was caused by corrosion or other causes. At the same time he knows just how much money he can spend for replacement of this

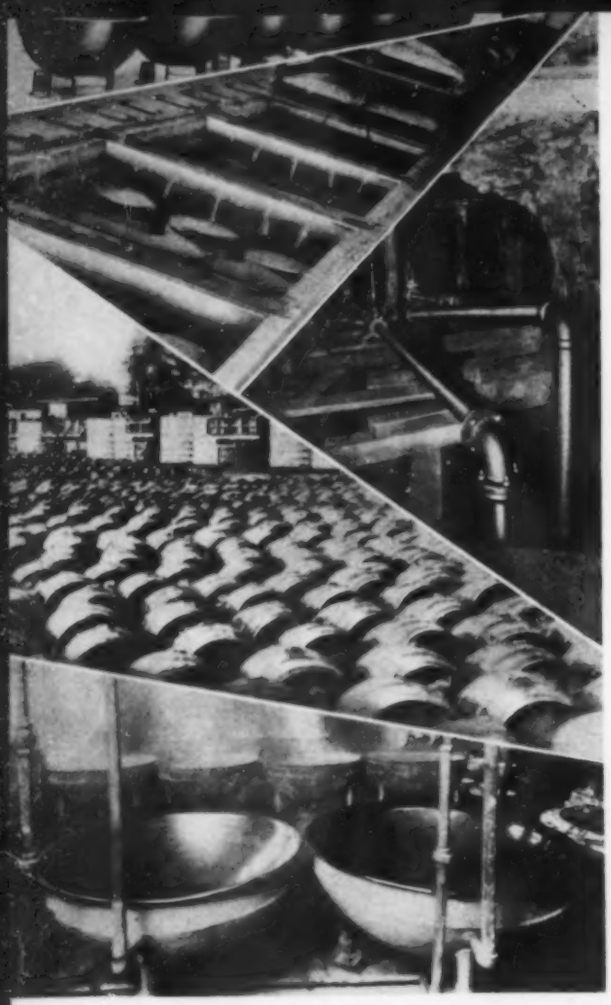
CONSTRUCTION

equipment with better materials, always remembering that the expected saving in maintenance must not be overshadowed by the increase in depreciation. It is often true that by reducing maintenance to a minimum, spare equipment can be eliminated and replacements with more expensive materials justified on this ground.

Having selected the point of attack, from examination of maintenance costs over a period of months or years, the next problem is selection of the proper material for replacement, which will either be a metal or a non-metal. If discussion of the uses of the former seems to have been overemphasized in the technical literature it is because alloys are being constantly added to, changed, and improved. Engineers are more familiar with the uses and limitations of materials such as wood, glass, brick, stoneware, and cement;—the original corrosion-resistant materials. Non-metals as a rule offer a much cheaper initial cost than metals and are accordingly given first consideration. On the other hand, metals which are really resistant, and which might be considered ideal for a particular chemical, usually offer reduced maintenance cost and lower depreciation charges.

Testing non-metallic construction materials is a much simpler procedure than testing metals; the fundamental reason for this is that non-metals, by their very nature, are not subject to the variable and often unpredictable electrolytic action which harasses the engineer working with alloys. Furthermore, the choice of non-metallic materials is limited to a dozen types, compared with hundreds of different metals and alloys, and no computations of penetration are necessary, even if they were possible. In other words, with a few exceptions a non-metallic material is either suitable or it is entirely unsatisfactory as far as resistance to corrosion is concerned, and a simple laboratory test will definitely determine whether or not its use is practicable. Most of the few hairline choices made between metals and non-metals have to be made in connection with wood. This material is generally so cheap that it may be replaced many times at the cost of similar metallic equipment. A case in point is the handling of weak acid solutions, when a decision has to be made whether or not to lead line a wooden vat. If plant authorities should differ on this point, it is sound business to install the vat without lining; if premature shredding or softening results, a lining can quickly be installed before the wood fibers have been seriously weakened.





Failure of non-metallic equipment is generally the result of mechanical weakness rather than from the solution or disintegration of the material itself. As these failures usually occur without warning, the cost of spare equipment must be taken into account, as well as possible contamination or loss of expensive product. For this reason some plants are willing to pay a higher initial cost for metal equipment to insure against loss of product or curtailment of production.

Among the most important non-metallic materials of construction are wood, rubber, glass, enamel, stoneware, brick, cement, plastics, and asphalt. Of these wood is by far the most widely used, the major part being employed in the construction of vats. There are few reactions for which a precedent as to its behavior has not been established, and the experienced engineer or chemist can nearly always decide at once whether or not it will be suitable. To be satisfactory for vat construction the wood must be of uniform grain, free of knot holes, and fairly tough. Cypress combines these qualities and has less tendency to shrink in slightly acid solutions than some hardwoods. For these reasons, and also because of its cheapness, it is widely used for this type of construction. But redwood, fir, pine, balsa, oak, and gum also have desirable qualities.

If a preliminary corrosion test on wood is deemed advisable, a piece should be immersed in the plant liquor at the operating temperature as long as practicable. If shredding or softening occurs within a few weeks use of the wood is not advisable. A visual comparison with an untested piece is usually sufficient to ascertain if any appreciable change in the fibers has occurred. The results of such a test have a negative value only, because no way of determining in advance the effects of erosion from agitation exists, especially if crystals are present. Unless negative results are obtained accelerated tests on wood are valueless, because more frequently than not, deterioration occurring at higher temperatures would otherwise be inappreciable. Wood, because of its cheapness, must sometimes be used in acid solutions for which it is not otherwise satisfactory. If the wood is impregnated with sulphur, an increase in life of 25 per cent or more is often obtained.

Increasing Use of Plastics and Rubber

Introduction of plastics and rubber linings in the chemical plant is a comparatively recent development and full advantage has not yet been taken of their valuable properties. Plastics are still too expensive to be used as freely as wood or the cheaper metals. They offer immense possibilities and are rapidly coming into use for acidproof accessories such as bolts, agitator arms, vat outlets, and dryer pans. They can be tested in the laboratory in the same way as wood, and with more positive results; this is possible because changes in temperature have apparently little influence on the chemical resistance of the resin, with the result that accelerated tests are of value. As with wood the test is continued as long as practicable. Where mechanical strength is required, plastics of laminated construction are used, the filler usually being cotton or linen. When immersed in liquids, absorption takes place and the filler deteriorates first. The extent of this deterioration can be observed after the test by examining a section of the material with a magnifying glass. In order to offer greater protection to the binder, whenever possible a thin layer of the plastic resin should be kept on the surface of the material. Where machining exposes the edge of the fabric longer life may be obtained by painting the exposed surface with Bakelite varnish.

Rubber and rubber-lined equipment, where they can be used, have proved themselves to be among the most satisfactory materials utilized in process work on account of their exceptional freedom from maintenance and their low initial cost. The use of rubber is limited to temperatures around 115 deg. C. and it cannot be used in contact with strong oxidizing agents or organic solvents. Rubber will also deteriorate when exposed to sunlight, but this fact need not concern the engineer in the average chemical plant where sunlight is at a premium. When the use of rubber is considered, the best procedure is to submit the problem with a sample of the liquid to be handled to one of the manufacturers of this type of equipment. These companies are able to vary their compounding process within certain limits, giving maximum service for a particular set of conditions. With their specialized experience and better facilities for testing, their engineers are able to reach more dependable conclusions regarding the advisability of using the product than is the average plant engineer.

So-called glass-lined equipment is useful for products which cannot be handled in metal or wood; it is especially valuable for products which require a high degree of purity. This type of equipment seldom needs preliminary testing as it can be used for practically all neutral and acidic solutions, the important exception being hydrofluoric acid. To take care of cases where accidents

occur to the enameled lining, a ceramic repair material has been developed recently. Repairs can be made successfully thus prolonging the life obtained from the equipment.

Such non-metallic materials as glass, stoneware, cement, acid proof brick, and asphalt, have specialized uses which are so well known that no preliminary testing is required. Stoneware, because of low initial cost, often offers the lowest depreciation charges, especially with small tonnages, and where vibration, shocks, and temperature changes are at a minimum. With the recent development in the glass industry many new uses may be found for it in the process industries within the immediate future.

Brick Suitable for Large Installations

Brick lined equipment finds its best field in comparatively large installations where cheapness of construction is of first importance. It is especially useful where a large amount of abrasion is encountered with little temperature change. The most serious drawback to brick linings is their tendency to leak if exposed to shock or vibration. Here, it may be mentioned that brick pans under filter presses handling strong acids is always a good investment. The brick can be laid on concrete and bonded with a 50:50 mixture of melted sulphur and ground silica. Mastic pans are cheaper and can be used to good advantage with very dilute acids.

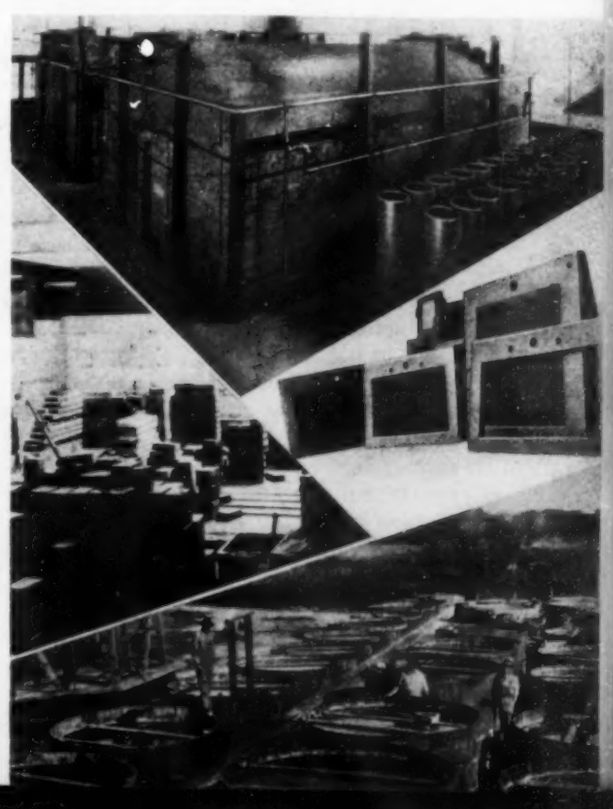
As previously stated the testing of metallic materials is a more complicated procedure. But fortunately it will not be necessary to try all of the several hundred materials available, for many of these can be discarded due to previous experience and information to be found in the technical literature. The ones which might work, but are obviously too expensive or unobtainable in the desired form can be weeded out, leaving, as a rule, only two or three to choose from. It is desirable to make laboratory corrosion tests of these materials, comparing them with the ones in use.

Samples of the metal to be tested must be free from surface defects and should be machined so that the thickness does not vary when measured by a micrometer. It is important to be able to measure accurately the thickness of the sample before and after the tests, because in the case of some alloys and particularly castings, small slag occlusions, or other foreign matter may dissolve out from the surface leaving little pit holes, which in no way depreciate the value of the material if it is satisfactory otherwise. If only the total loss of weight is taken as an indication of corrodability, the solution of these surface defects may show considerable loss, whereas the actual decrease in thickness may be negligible. These tests should be made only in samples of the actual plant liquors, in which they are to be used, preferably at plant operating temperatures. If air agitation is used in the plant, it is important to bubble air through the liquid covering the test piece. When other types of agitation are used in the plant, some approximation of this should be attempted in the laboratory. It is of course important that no other metal come in contact with the solution or the test piece. These tests are continued until appreciable solution of the material being used as a standard has occurred. Then the samples are removed and the penetration in inches per year calculated, either from the total loss in weight with homogeneous substances showing no surface defects, or by actual measurement, with materials from which occluded surface impurities have been dissolved.

When these laboratory tests have indicated the most suitable material to use, a test should be made by using the material as part of the plant equipment. This can be done inexpensively by fastening a piece of the material to an agitator arm or by making an entire agitator from it. One of the easiest ways is to use bolts made from the material; another method is to insert a piece of pipe in a hose line. Numerous other ways are possible, depending on the type of equipment used. It is just as important in this plant test as in the laboratory that no metals be present in the corrosive liquid other than the one being tested. When this is impossible, such a test may mean little; therefore, the next best thing is to make a small piece of equipment from the material and try it out in the semi-plant or laboratory under plant process conditions. The length of time this plant test continues depends on the ultimate investment contemplated. An alloy which is being considered for the fabrication of an autoclave costing $5,000, for example, should be under test for a much longer period than if the investment were only a few hundred dollars.

Proper Selection Important

It sometimes happens that one metal is outstandingly better than the other materials tested both in the laboratory and plant and can be used without further delay. Most frequently, however, several materials will compare closely as to the calculated penetration in inches per year, especially when the cost of the equipment is taken into consideration. When this question arises, it is best to calculate the replacement cost on the basis of one year justification; i.e., will expected saving be equal to at least a year's depreciation on the present equipment? Let us suppose for example that it is a question as to whether a still should be fabricated from Monel metal or should simply be lead lined. Laboratory and plant



corrosion tests may show that lead dissolves a little more than twice as fast as Monel. If the Monel equipment costs only twice as much as lead, assuming maintenance costs to be equal, no saving is indicated; and under actual service conditions the Monel might not last twice as long as lead (it is never safe to assume the other possibility), in which case the cost of the product would be increased rather than decreased. If, on the other hand, the Monel equipment can be shown to be more efficient than the lead so that one Monel still can replace two that are lead lined, then a clear saving is indicated, which will be realized even though the alloy does not stand up so well as was expected. Of course, after a certain material has actually been tried out over a period of time, its depreciation rate is known more accurately and may be adjusted to the new basis.

Importance of Tests Under Operating Conditions

The importance of these preliminary tests under actual plant operating conditions cannot be minimized, for they are of much more value than the laboratory results. Where more than one unit of equipment is available, several materials can be tested simultaneously; and occasionally with experience and judgment, the materials may be tested comparatively in dissimilar metal equipment.

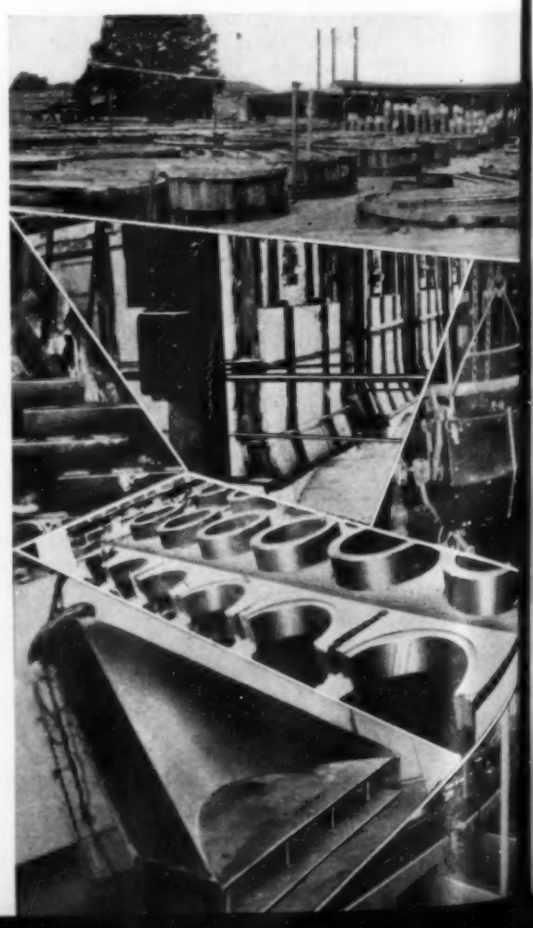
We now come to the question of selecting the proper material when two or more substances in the same price range show a penetration in inches per year within about 15 per cent of each other. In this case laboratory tests should be made at elevated temperatures—the higher the better—and the costs figured on this basis, since it is rare indeed that a material will stand up better at higher temperatures than at lower ones. If there is still little to choose from, the well of experience must be drawn upon, which usually results in the selection of the material which can be fabricated or repaired most easily. Laboratory corrosion tests are valuable chiefly as a comparison between different substances, and the results should be viewed with a jaundiced eye when the calculated penetration in inches per year is to be taken as a basis for figuring depreciation costs. Generally speaking, any material (with the possible exception of ordinary lead linings) which corrosion tests indicate will have to be replaced in less than three years should not be considered.

Designing Semi-Plant Equipment

Next follows the question of the selection of proper materials of construction to be used as full scale equipment for a process developed in the laboratory for introduction into the plant on a production basis for the first time. It is seldom that a new process involving appreciable equipment expense is introduced into full scale production without first going through further development in the semi-plant. A point often overlooked is that a semi-plant development is equally as valuable to the engineer as to the chemist, since it enables him to experiment with various types of equipment, often having the same effect on yield and quality of the product as temperatures, concentrations, and other variables of the process itself.

In designing semi-plant equipment it is obviously a waste of money to use materials which because of their expense or difficulty of fabrication could not possibly be used for full scale equipment. Laboratory tests as outlined above should be made; and if two materials give results within 25 per cent of each other, the cheaper material should ordinarily be chosen for the initial installation. It is the rule rather than the exception in semi-plant development work that variables such as concentrations and temperatures are so frequently changed that a measurement of corrodability means little until the process in a particular piece of equipment becomes standardized. When this occurs, measurement of the rate of solution of the material may begin; and if it is unsatisfactory, a new piece of equipment may be made from a material which laboratory tests have shown might be satisfactory. This procedure may delay the completion of semi-plant development; but one unhealthy experience in designing full scale equipment too rapidly is enough to satisfy the engineer that a few months additional semi-plant work is more than made up by smoothness in the running of the full scale plant. Where it can be done, time will be saved by trying out two or more materials simultaneously, as previously outlined.

Occasionally, where little equipment expense is involved, processes are put into full scale production without going through the semi-plant stage. When this procedure is decided upon, laboratory tests and previous experience are the only guides that can be followed in the selection of suitable materials of construction. In general, materials which tests indicate will not last three years should not be considered unless the installation is of a temporary character. As stated before, this is a good rule to follow even though the cost of the product may appear to be increased a little by the use of more expensive materials.



MODERN MATERIALS

Other Than Metals and Alloys
For the Construction of Chemical Engineering Equipment

DUE to the demand for improved manufacturing efficiency there is increasing interest among chemical engineers for more data concerning the mechanical, physical, and chemical properties of the various materials of construction. Because of this demand, *Chem. & Met.* has revised and expanded the Non-Metallic section of the "Materials of Construction for Chemical Engineering Equipment," originally published as an editorial supplement to the September, 1929, number. The revision of the Metals and Alloys section of that supplement was published in the September, 1932, number.

Data appearing in most of the tables of physical and mechanical properties are based upon material contributed by the manufacturers at the request of the editors. Those data concerning refractories and acid-resisting cements for bonding are tabulated as supplied by the respective makers. The recommended applications for chemical resistance are those of the manufacturers to whom uniform questionnaires were submitted. Since, in most cases, it is impossible to make more than a general recommendation regarding the resistance of a material to a chemical solution it is strongly urged that the user submit his problem to the manufacturer of the construction material with complete information concerning the actual conditions met with in the plant.

The chemical resistance of the materials of construction can be found on pages 654 and 655; the physical and mechanical properties as follows:

Enameled-lined steel 651
Glass and fused silica..... 651
Chemical stoneware 651
Wood 651
Acid-resisting cements 652
Asbestos-portland cement 653
Coke base carbon..... 653
Refractories 653
Rubber 653
Vulcanized fiber 653
Plastics 656-657
Heat-insulating materials 658

Glass Lined and Enameled Steel

(a) Coefficients of Heat Transfer for Typical Chemical Enamels.*
(In B.t.u.'s per sq.ft. per hr. per deg. F. of temperature difference.)

1. Dry dust enamel for very severe chemical service (Pfaudler No. 17).

Steam to water being heated..... K = 60
Steam to boiling water..... K = 80

2. Dry dust enamel for very severe chemical service (Pfaudler No. 11).

Steam to water being heated..... K = 50
Steam to boiling water..... K = 70

3. Spray enamel for organic acids and less corrosive mineral acids (Pfaudler No. 71).

Steam to water being heated..... K = 125
Steam to boiling water..... K = 150

4. Spray dust enamel for mineral acids in general storage service, usually for equipment of large capacities (Pfaudler No. 186).

Steam to water being heated..... K = 90
Steam to boiling water..... K = 100

*We wish to point out that agitation and size of enameled piece as related to agitation are determining factors in establishing accurate coefficients of heat conductivity for equipment of this kind. Good agitation may increase values by as much as 20 to 25 per cent.

(b) Other Physical and Mechanical Properties.

Such physical properties of enamel as the coefficient of expansion, tensile strength, etc., are generally meaningless unless considered in connection with the steel on which the lining is applied. Ability to withstand rapid thermal change is tested in an automatic machine by intermittently heating enamel plates to 450 deg. F. and then dipping them into ice water. However, both temperature and corrosion conditions to be met in each service application should be definitely ascertained and this information supplied to the manufacturer. The manufacturers' recommendations for corrosion resistance are given in accompanying table.

Glass and Fused Silica

Properties	Boro-Silicate Glass	Fused Silica Clear	Fused Silica Opaque
Marketed forms, S = Sheets, T = Tubes, R = Rods	S,R,T, forms	S,R,T, forms	S,R,T, forms
Thickness, 1/1000 in.	10 up	1 up	5 up
Transparency, T = Transparent, TL = Translucent, O = Opaque	T, TL	T	TL, O
Specific Gravity	2.24	2.20	2.07–2.1
Specific Volume, in.^{3} per lb.	12.3	12.6	13.4
Tensile Strength, lb. per in.^{2}	10,000	7,000	7,000
Modulus of Elasticity, lb. per in.^{2} x 10^6	93	105–126	94–114
Hardness, 2.5 mm. ball, 25 kg. load, depth in 1/200 mm.	3	4.9	.....
Thermal Expansion, 10^{-6} deg. C.	0.32 (0-300°C.)	0.049	0.053–0.059
Thermal Conductivity, 10^{-4} cal. per sec. cm. deg. C.	27	23.7	19–20
Specific Heat, cal. per deg. C. gm.	0.20	.....	.....
Softening Point, deg. F.	1,290	2,600	2,600–2,700
Breakdown Voltage, 60 cycle, volts per mil.	1,400 (0.1 in. sample)	410 (¼ in.)	436 (¼ in.)
Dielectric Constant, 60 cycle	4.86	3.7	3.7
Refractive Index—N_D	1.47	1.459	.....

Chemical Stoneware

Ultimate compressive strength, lb. per in.^{2}	82,000–115,000
Ultimate tensile strength, lb. per in.^{2}	1,650– 4,300
Modulus of elasticity, lb. per in.^{2}	1.05–5.95x10^6
Specific heat	0.2
Thermal conductivity, B.t.u. per ft.^{2}	0.78–2.05
Linear expansion, per deg. F.	1.9–2.3x10^{-6}
Ultimate bending strength, lb. per in.^{2}	5,900–12,500

Physical Properties of Wood

	Redwood	Pine	Oak	Fir	Cypress	Gum	Ash	Chestnut	Elm	Maple
Specific gravity	0.34–0.41	0.61–0.75	0.77	0.59	0.53	0.45	0.51	0.40	0.48	0.49
Tensile strength, lb. per in.^{2}	4,500	5,100	4,400	3,600	4,400	....	....	....	....	....
Compression strength, lb. per in.^{2}	3,400	3,420	2,800	2,400	3,560	....	....	....	....	....
Transverse strength, lb. per in.^{2}	....	5,700	4,425	....	....	....	....	....	....	....
Linear expansion, per deg. F.	Negligible	....	....	....	....	....	.0000053	.0000036	.0000031	0000035
Hardness	Moderately Hard	Hard	Hard	Med.	Med.	Medium	Hard	Hard	Medium	Medium

Acid Resistant Cements for Brick, Metal, Earthenware, Stoneware, Fused Silica

Product Manufacturer	"Acidproof Cement No. 1" Quigley Co., Inc., New York, N. Y.	"Acidproof Cement No. 2" Quigley Co., Inc., New York, N. Y.	"Acipruf" Chemical Construction Corp., Charlotte, N. C.	"Basolit" Nukem Products Corp., Niagara Falls, N. Y.
Used for	Brick, for chimneys and flues	Brick and tile tank settings, chemical stoneware, fused silica	Brick, chemical and terra-cotta stoneware, rigid joints	Brick, porcelain, metal, chemical and terra-cotta stoneware, rigid joints
Composition				Silica-sulphur
Preparation for use	Ready mixed	Ready mixed	Mix with sodium silicate	Heat to 300° F. and pour
How applied	Trowel, or dip bricks	Trowel	Trowel, with thin joints. For bell-and-spigot joints, press over asbestos rope	Pour into joints, with or without asbestos rope packing
Resistant to	Hot acid gases	Strong and weak mineral acids	Mineral acids	Acids, fumes
Temperature range	to 2,400° F.	to 1,200° F.	to above boiling points of strongest acids	to 200° F.

Product Manufacturer	"Calktite" U. S. Stoneware Co., Akron, O.	"Carolina" Charlotte Chemical Laboratories, Inc., Charlotte, N. C.	"Chemical Putty" Charlotte Chemical Laboratories, Inc., Charlotte, N. C.	"Duralute" U. S. Stoneware Co., Akron, O.
Used for	Brick, bell-and-spigot joints on chemical stoneware	Brick, chemical and terra-cotta stoneware, rigid joints	Chemical stoneware, fused silica, Duriron, non-rigid joints	Brick
Composition	Asphaltic base		Asbestos base	Asphaltic base
Preparation for use	Heat and pour	Ready mixed	Ready mixed	Heat and pour
How applied	Pour into brick joints. For stoneware, pour over tamped asbestos wicking	Trowel, with thin joints. For bell-and-spigot joints, press over asbestos rope	Press into joints	Pour into brick joints
Resistant to	Acids	Mineral acids	Mineral acids	Acids, alkalis
Temperature range	to 200° F.	to above boiling points of strongest acids	to 250° F.	to 200° F.

Product Manufacturer	"Duro" Special Electrochemical Supply & Engrg. Co., Paoli, Pa.	"Duro" Standard Electrochemical Supply & Engrg. Co., Paoli, Pa.	"M. A. Knight Acidproof" Maurice A. Knight, Akron, O.	"Portite" U. S. Stoneware Co., Akron, O.
Used for	Brick, metal, glass, stoneware, earthware, fused silica, bell-and-spigot joints	Brick, metal, earthenware, chemical stoneware, fused silica, glass	Brick, chemical stoneware	Brick
Composition				Asphaltic base
Preparation for use	Mix two ingredients to consistency of thin putty	Mix two ingredients to consistency of thin putty	Mix with sodium silicate to consistency of cream	Heat and pour
How applied	Trowel, joints thin or thick as desired. Heat to hasten drying	Trowel, thin joints. Heat surfaces before or after joining to hasten drying	Heat bricks to about 150° F. Lay with thin joints	Pour into brick joints
Resistant to	Weak acids, salts, fumes	Strong mineral acids, fumes	Acids	Acids
Temperature range	to 1,500° F.	to 1,500° F.	to 300° F.	to 200° F.

Product Manufacturer	"Mineralead" Atlas Mineral Products Co., Mertztown, Pa.	"Pre-Mixt" U. S. Stoneware Co., Akron, O.	"S" Brand Silicate Philadelphia Quartz Co., Philadelphia, Pa.	"Thiogrout" Electrochemical Supply & Engrg. Co., Paoli, Pa.
Used for	Cast iron	Brick	Brick	Bell-and-spigot joints
Composition	Sulphur base		50 ground quartz, 20 mesh, 50 ground quartz, 100 mesh, 70-100 "S" Brand silicate	Sulphur base
Preparation for use	Heat to 270-280°F. and pour	Mix with water to consistency of heavy cream	Mix to consistency of thick cream	Melt and pour
How applied	Pour over jute caulking	Bricks should be warm. Lay with thin joints	Dip bricks, lay with thinnest possible joints	Pack joint with asbestos rope and pour on cement
Resistant to	Solutions with pH under 7	Acids, neutral solutions	Acids, fumes	Weak acids, salts
Temperature range	to 200° F.	to 600° F.		to 220° F.

Product Manufacturer	"U. S. Standard" U. S. Stoneware Co., Akron, O.	"Vitric-10" U. S. Stoneware Co., Akron, O.	"Vitrite-15" U. S. Stoneware Co., Akron, O.	"Vitrobond" Atlas Mineral Products Co., Mertztown, Pa.
Used for	Brick	Brick	Brick	Brick, tile
Composition				Sulphur base
Preparation for use	Mix with sodium silicate to consistency of heavy cream	Mix with sodium silicate to consistency of heavy cream	Mix with sodium silicate to consistency of heavy cream	Heat to 265° F. and pour
How applied	Bricks should be warm. Lay with thin joints.	Bricks should be warm. Lay with thin joints	Bricks should be warm. Lay with thin joints	Pour into joints
Resistant to	Acids	Acids	Acids	Acids
Temperature range	to 350° F.	to 500° F	to 500° F	to 212° F

Properties of Coke Base Carbon

Specific gravity	2.00–2.15	Coeff. of ther. expan., deg. C. (100—150 deg. C.)	1.5–2.10x10^{-6}
Apparent density	1.42–1.65	Specific heat, cal. per gm. per deg. C. (26—282 deg. C)	0.200–0.250
Porosity, per cent	25–30	Volatilization pt., deg. F	6,300–6,700
Tensile strength, lb.	600–650	Ash, per cent	0.5–10.0
Crushing strength, lb. per in.^{2}	5,500–9,000	Start of oxidation, deg. F	625–840
Transverse strength, lb. per in.^{2}	2,000–6,000	Machining qualities	Good
Ther. conductivity, cal. per cm. per deg. C.	0.007–0.008	Available in	Rod, tube, brick, plates, shapes

Vulcanized Fiber

Marketed forms: S — sheet; R — rod; T — tubes	S. R. T.
Thickness — 1/1000 in.	4 up
Forming properties	Good
Machining qualities	Good
Colors	Red, brown, white, gray, black, olive
Effect of heat	Stable to charring
Effect of water	Swells and softens. Warps on drying. Not recommended.
Effect of mineral, animal and vegetable oils	Very slight absorption
Specific gravity	1.2–1.5
Specific volume in.^{3} per lb.	23–18.5
Tensile strength lb. per in^2	8,000–16,000
Breakdown voltage, 60 cycle ($\frac{1}{16}$ in. sample) volts/mil	175–500

Asbestos Fiber and Portland Cement

Form	Flat Sheets	Corrugated Sheets	Pipe	Impregnated Material
Sizes	36x48* 42x48* 42x96*	42 in. wide 3-11 ft. long $\frac{1}{4}$ in. thick	0-225 lb. per in.^{2} pressure	Same as plain
Temperature limit, deg. F	700	700	700	150
Density, lb. per ft.^{3}	125	125	125	128
Water permeability.	Low	Low	Extremely low	Extremely low
Modulus of rupture, lb. per in.^{2} (Avg.)	3,500	3,000	.....	.....
Modulus of elasticity	1,500,000	1,500,000	2,000,000	1,500,000
Electrical resistance	.....	.....	.....	4,000,000 megohms per inch cube

* $\frac{1}{4}$ in. to 4 in. thick

Hard and Soft Rubber

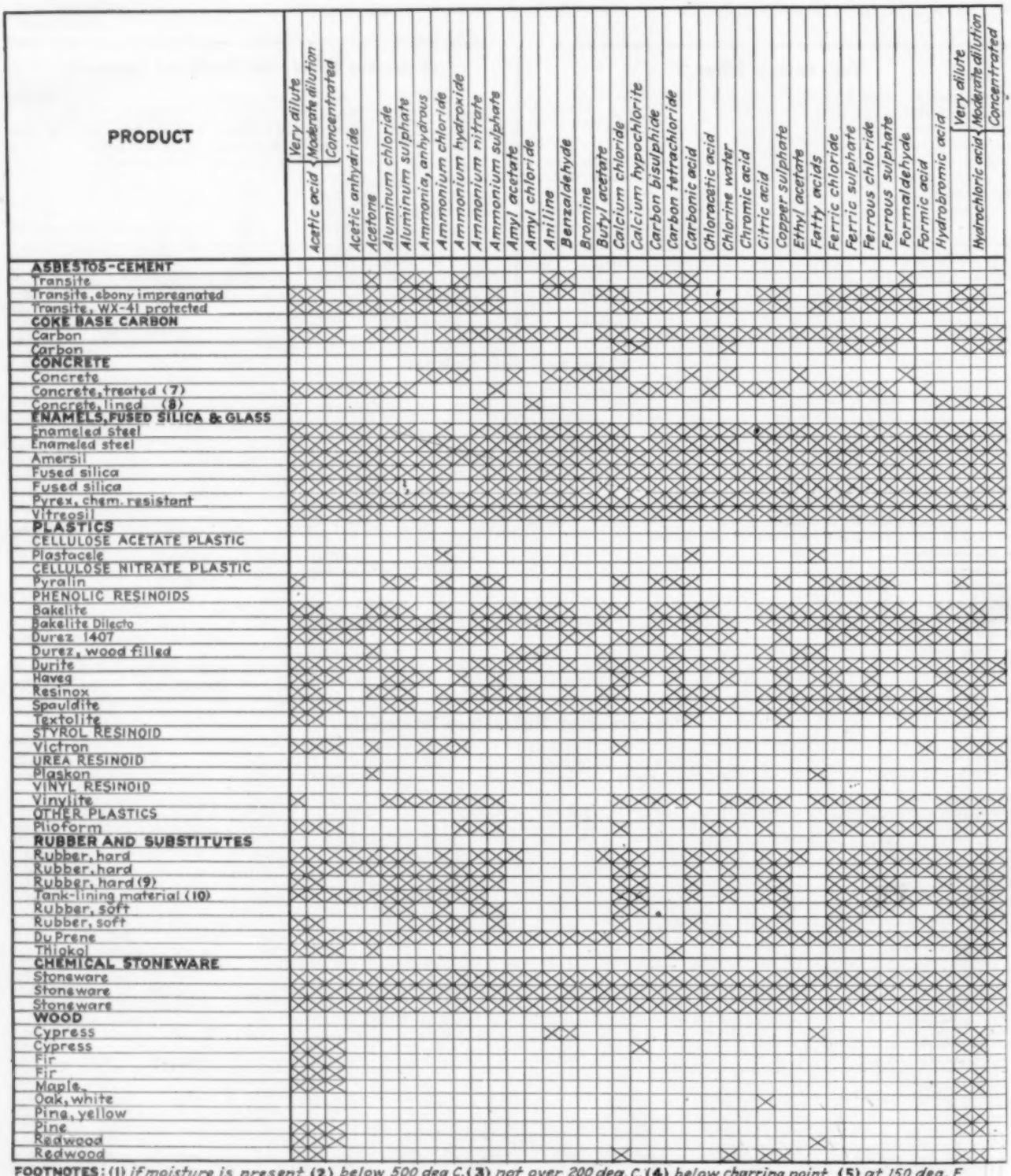
Product	Hard	Soft	Linings
Specific gravity	1.12–2	0.97–1.25	0.98–1.35
Tensile strength, lb. per sq.in.	1,000–10,000	525–600	.....
Tranverse strength	9,000–15,000	.....	.....
Compression strength, lb. per sq.in.	2,000–15,000	.....	.....
Hardness-sclerescope	50–80	.....	.....
Maximum temp. for use, deg. F	130–160	150–200	190
Effect of heat	Softens	Softens	Softens
Coef. of linear expansion, 32-140 deg. F.	.000035	.000036	.....
Coef. of heat conductivity. K in B.t.u. per sq.ft. per in. per deg. F. difference in temp.	1.07	1.07	.....
Resistance to abrasion	.....	20 times steel	.....
Resistance to tear, lb. per sq.in.	.....	15–80	.....
Dielectric strength, volts per mm.	25,000–40,000	25,000–40,000	.....
Effect of sunlight	Slight discoloration	Cracks	Ages
Effect of aging	Nil	Slight	Tendency to harden at normal temp.
Machining qualities	Good	Can be ground	.....
Available forms	Pipe and fittings, tank and pipe linings, misc. forms	Tank linings, hose, misc. forms	Tank, vat, pipe, valve linings for chemical and abrasion protection

Properties of Refractory Materials

Type of Brick	Chrome	No. 1 Fire Clay	Fused Alumina	Fused Refractory	Kaolin	Kaolin Refractory Insulator	Magnesite	Mullite Refractory	Silica	Silicon Carbide	Unburned Magnesite
Typical composition in per cent	44 Cr_2O_3 16 Fe O 15 Mg O 15 Al_2O_3 5 $Si O_2$	42 Al_2O_3 54 $Si O_2$ 2 Flux	90 Al_2O_3 7 $Si O_2$ 3 Flux	75 Al_2O_3 20 $Si O_2$ 3.3 $Ti O_2$	45 Al_2O_3 52 $Si O_2$ 1 Flux	45 Al_2O_3 52 $Si O_2$ 1 Flux	85 Mg O 7 Fe_2O_3 3 Ca O 3 $Si O_2$	52 Al_2O_3 44 $Si O_2$ 2.5 Flux	96 $Si O_2$	100 Sic	7 Al_2O_3 7 Cr_2O_3 69 Mg O 6 Fe_2O_3 4 Ca O 7 $Si O_2$
Fusion point, deg. F.	4000	3050	3500	3360	3200	3200	4000	3300	3050	4000 (decomp.)	4000
Load resistance, temp. deg. F. for 10 per cent shrink at 25 lb.	2600	2700	2800		2900		2500	3000	3000	3100	
Resistance to spalling in cycles	2	20	4		20		1	25	None	25	5
Weight per brick (standard 9 in.) in lb.	11.1	7.5	10	10	7.5	1.8	10	7.0	6.5	9	10.4
Porosity in per cent		20–30	20	0.4	20	80		25	20–30	18	15
Specific heat (60-1200 deg. F.)	0.20	0.23	0.20	0.23–0.255	0.23	0.23	0.27	0.23	0.23	0.20	
Relative slag resistance											
Acid steel slag	Poor	Fair	Good		Fair	Poor	Fair	Good	Good	Good	Good
Basic steel slag	Good	Poor	Good		Poor	Poor	Good	Fair	Poor	Good	Good
Mill scale	Good	Poor	Fair		Poor	Poor	Good	Fair	Poor	Fair	Good
Coal ash slag	Fair	Fair	Good		Fair	Poor	Good	Fair	Fair	Good	Fair
Approximate cost per M 9-in. equivalent, in dollars	250	35–40	1000	1000	260	170	350	100	40–50	1000	275

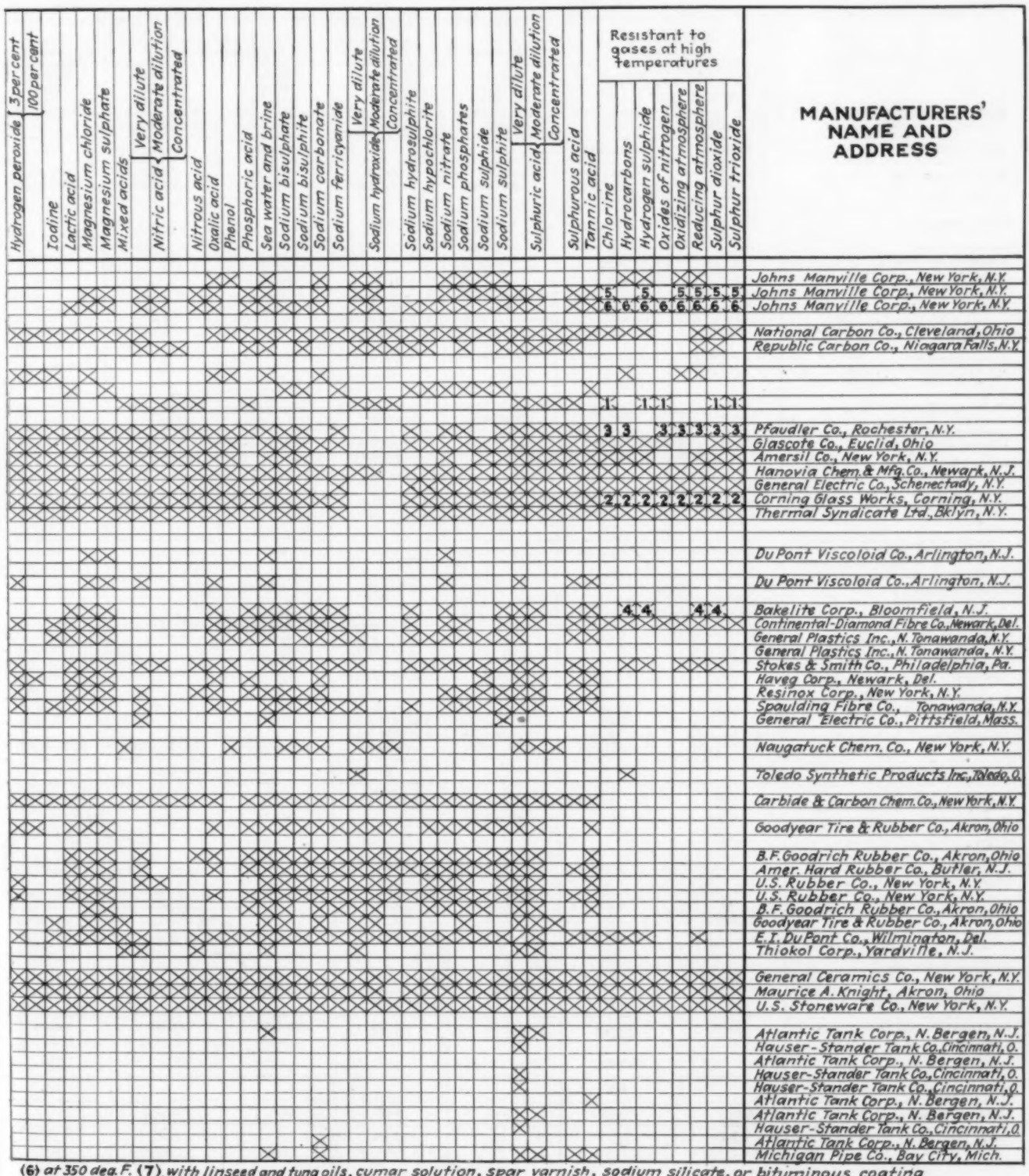
Based on a tabulation by F. H. Norton, published in *Chem. & Met.*, April, 1932, p. 227. Additional information supplied by Corhart Refractories Co., Norton Co., Vitrefrax Corp., The Carborundum Co. and General Refractories Co.

Manufacturers' Recommendations for the Corrosion



FOOTNOTES: (1) *if moisture is present* (2) *below 500 deg C.* (3) *not over 200 deg. C.* (4) *below charring point* (5) *at 150 deg. F* (8) *with acid-proof brick or tile, lead, rubber, bituminous mastic or other lining* (9) *molded and fabricated parts*

Resistant Non-Metallic Materials of Construction



(6) at 350 deg. F. (7) with linseed and tung oils, cumar solution, spar varnish, sodium silicate, or bituminous coating
(10) rubber bonded to metal, storage and process tanks

Mechanical, Physical, and Electrical Properties of the

Characteristics	PHENOLIC RESINOIDS						Urea-Formaldehyde Resinoid, Molding Plastic
	Pure Hardened Resinoid	Molded			Laminated		
		Wood Flour Filler	Fabric Filler	Asbestos Filler	Paper Filler	Fabric Filler	
Marketed Forms, S = Sheets, T = Tubes, R = Rods	S, R, castings for machining	Misc. molded forms	Misc. molded forms	Misc. molded forms	S, R, T, and pressed forms	S, R, T, and pressed forms	Molded forms
Molding Qualities	Machined	Excellent	Good	Good	Excellent	Excellent	Good
Molding Range, deg. F.		300-450	300-360	300-340	250-325	250-325	275-300
lb. per in.^{2}		500-2,500	3,500-5,000	1,500-2,500	1,000-2,000	1,000-2,000	2,000-10,000
Compression Ratio, Vol. loose powder / Vol. solid		2.0-3.5	4.5-7.5	2.3-7.0			3
Tendency to Unmold		None	None	None	None	None	None
Thickness, 1/1000 in.	10 up	20 up	20 up	20 up	5 up	5 up	20 up
Machining Qualities	Good	Good	Fair	Fair	Good	Good	Fair
Tendency to "Cold Flow"	None	None	None	None	None	None	None
Transparency, T = Transparent, TL = Translucent, O = Opaque	T, TL, O	O	O	O	O	O	T, TL, O
Colors and Mottles	All colors	Variety	Natural, darker shades	Natural, darker shades	Natural, dark	Natural, dark	Unlimited
Effect of Heat, Dry	Withstands 250 deg. F. Tends to harden and shrink; improved electrical properties			Withstands constant use at 375 deg. F. Special grade 475 deg. F.	Withstands 250 deg. F. with slight hardening and shrinkage		Slight shrinking
Moist							Slight swelling
Burning Rate	Extremely low	Extremely low	Extremely low	Practically incombustible	Extremely low	Extremely low	Very low
Effects of Light, Sunlight	Slight lowering of surface resistivity and darkening in light colors according to intensity of ultra-violet light						None
Ultra-Violet							
Effects of Aging	None		Improvement in mechanical and electrical properties				None
Effects of Water, Cold		None		Very resistant	Slight deterioration on long immersion. Effects more rapid		None
Hot							None up to 30 min. boiling
Specific Gravity	1.2-1.3	1.3-1.4	1.3-1.4	1.8-2.0	1.3-1.4	1.3-1.4	1.48-1.55
Specific Volume, in.^{3} per lb	23-21	21-20	21-20	15-14	21-20	21-20	18-19
Tensile Strength, lb. per in.^{2}	"8"-test piece 5,000-11,000	A.S.T.M. test 6,000-12,000	A.S.T.M. test 4,500- 9,000	A.S.T.M. test 5,000-10,000	6,000-20,000	8,000-12,000	5,000- 6,400
Elongation, per cent							
Impact Strength, Izod	0.5-2.5	1-2.5	10-25	0.5-4.0	5-25	10-65	0.7-1.2 (Sharpe)
Modulus of Elasticity, lb. per in.^{2} x 10^6	1-2.5	1-2.5	0.8-1.2	1-2.5	0.5-2	0.5-1.5	
Hardness, 2.5 mm. ball, 25 kg. load, depth in 1/200 mm.							
Thermal Expansion, 10^{-5} per deg. C.					2	2	
Thermal Conductivity, 10^{-4} cal. per sec. cm. deg. C.	3-4	4-6	4-6	12-20	5-8	5-8	
Specific Heat, cal. per deg. C. gm.	0.33-0.36	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40	
Softening Point, deg. F.							
Electrical Resistivity, (volume) 30 deg. C., 10^{10} ohm cm.	1-1,000	1-100	0.1-10	0.01-0.1 Mica filler 10-1,000	1-100	0.1-1.0	
Breakdown Voltage, 60 cycle volts per mil	250-700	300-600	200-500	150-400 Mica filler 450-600	500-1,300	200-600	300-400
Dielectric Constant, 60 cycle		4.5-8.0					5-6
Power Factor, 60 cycle, per cent		4-20					1-3
Dielectric Constant, R. F.	4.5-7.0	4.5-8.0	4.5-7.0	5-20	4.5-6	4.5-7.0	
Power Factor, R. F., per cent	0.5-5.0	1-10	5-10	0.7-2.5 10-20 mica filler	1.5-5	2-8	
Refractive Index, N_D	1.56-1.70						1.6

Phenol, Urea, Cellulose, Vinyl, Styrol, and Rubber Plastics

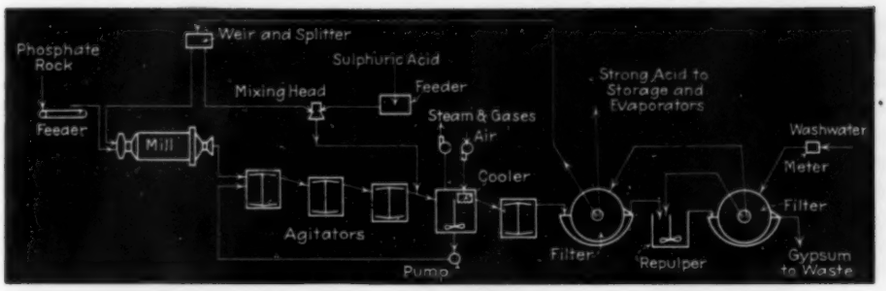
Characteristics	Cellulose Nitrate	Cellulose Acetate		Vinyl Resins		Styrol Resin	Resin Derived from Rubber
	Plastic	Plastic	Press Powder	Filled	Unfilled		
Marketed Forms, S = Sheets, T = Tubes, R = Rods	S,T,R, and misc. forms	T,S,R and misc. forms	T,S,R, and misc. forms	S,T,R	S,T,R	S,T,R	Misc.
Molding Qualities	Very good	Fair to good	Fair to good	Good	Good	Thermoplastic	Good
Molding Range, deg. F. lb. per in.^{2}	190-220 2,000-5,000			200-300 300-2,000	200-300 300-2,000	200-350 40-100	230-300 1,500-3,000
Compression Ratio, Vol. loose powder / Vol. solid			2.28-2.84	2.5	2.5		2.5 to 1
Tendency to Unmold	Low	Low	Med. to high	None	None	None	None
Thickness, 1/1000 in.	5 up	5 up	20 up				10 up
Machining Qualities	Good	Fair to good	Fair to good	Good	Good	Good	Good
Tendency to "Cold Flow"		Depends on plasticizer	Depends on plasticizer			Slight when uncompounded	Some
Transparency, T= Transparent, TL= Translucent, O= Opaque	T, TL, O	T, TL, O	TL, O	T, TL, O	T, TL, O	T, TL, O	T, TL, O
Colors and Mottles	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Any color	Unlimited
Effect of Heat, Dry Moist	Decomposed at 100-150 deg. C.	More stable than cellulose nitrate at 150 deg. C.		150 deg. C. slowly darkens	150 deg. C. slowly darkens	Will soften under high heat	Becomes insolubl Thermoplastic
Burning Rate	Very high	Low	Low	Nil	Nil	Compounded material will not support combustion	Medium
Effects of Light, Sunlight Ultra-Violet	Discolored and brittled	More stable than cellulose nitrate				Slight surface oxidation	Slight Slight
Effects of Aging	None in absence of ultravoilet light	Less than cellulose nitrate		None	None	None	None
Effects of Water, Cold Hot	Swelling is very slight	Slight swelling Attacked	Slight swelling Attacked	None below 150°F. Softens	None below 150°F. Softens	None None	None None
Specific Gravity	1.35-1.60	1.27-1.31	1.30-1.63	1.2-2.5	1.23	1.06 (uncompounded)	1.06-1.35
Specific Volume, in.^{3} per lb.	20.5-17.3	21.8-21.2	17.0-21.3	20-15	19	Varies	26.1-20.5
Tensile Strength, lb. per in.^{2}	4,000-10,000	5,400	1,800-3,200	7,000	9,000	Varies	4,500-7,000
Elongation, per cent	5-30	13	0.2-0.5			Varies	Very little
Impact Strength, Izod	10-11.5		0.17-0.62	0.24-1.22	0.2-3.5	Varies	
Modulus of Elasticity, lb. per in.^{2} x 10^6	2.0-3.9		1.1-2.9	7.5		Varies	
Hardness, 2.5 mm. ball, 25 kg. load, depth in 1/200 mm.	45-65	45-65				Varies	
Thermal Expansion, 10^{-5} per deg. C.	12-16		14-16			Varies	
Thermal Conductivity, 10^{-4} cal. per sec. cm. deg. C.	3.1-5.1	5.4-6.3	5.3-8.7			Varies	
Specific Heat, cal. per deg. C. gm.	0.34-0.38						
Softening Point, deg. F.	160-195	115-160	162-300	160	150	194 and up	160 up
Electrical Resistivity, (volume) 30 deg. C., 10^{10} ohm cm.	0.106-0.32	0.30	6.2	>10	>10,000		
Breakdown Voltage, 60 cycle volts per mil	300-780	720	590-620	350-400	400-500	517	
Dielectric Constant, 60 cycle	7.3-6.7	7.5	7.1-8.4			2.96	
Power Factor, 60 cycle, per cent		7.0	9.1-10.5			0.03	
Dielectric Constant, R. F.	6.8	5.3	4.3-5.4	5.0	4.0	2.96	
Power Factor, R. F., per cent	9.7-7.4	13.7	6.8-10	6.2	1.43	0.03	
Refractive Index, N_D	1.50	1.49-1.50					1.60-1.66

Physical and Thermal Properties of Heat-Insulating Materials

Material	General Composition	Commercia Construction	Density in Lb. per Cu.Ft.	Temp. Limit Deg. F. for Commercial Service	Thermal Conduct. B.T.U. per Hr. per Sq.Ft. per In. per °F. = K	Mean Temperature of Sample Deg. F.	Resistance per Inch of Thickness 1/K	Authority
Air	Still air		.08	.....	0.157	32	6.37	Int. Critical Tables
Cattle Hair	Hair-felted	Blanket flexible	9.25	100	0.272	60	3.68	.....
Cattle Hair	Hair-felted	Blanket flexible	16.88	.....	0.247	86	4.05	Bureau of Standards
Cattle Hair and Jute	Hair and jute felted	Blanket flexible	6.17	100	0.245	60	4.08	.....
Cattle Hair and Other Fiber	Confined with building paper	Blanket flexible	18.72	.....	0.2702	86	3.70	Bureau of Standards
Wool Paper and Hair	Lam'nated	Pipe covering	15.6	100	0.308	50	3.25	.....
Corkboard	No artificial binder	Pressed rigid slabs	7.0	.....	0.27	.....	3.71	Bureau of Standards
Rock Cork	Rock wool and asphalt binder	Rigid slabs	15.6	100	0.328	86	3.05	Bureau of Standards
Kapok Fiber	Tightly packed	Flexible	....	100	0.341	78	2.93	Int. Critical Tables
Insulating Boards	Pressed wood pulp	Rigid slabs	17.0	200	0.356	90	2.81	.....
Insulating Boards	Bagasse fiber	Rigid slabs	17.5	200	0.363	90	2.76	.....
Insulating Boards	Licorice roots	Rigid slabs	16.1	200	0.340	81	2.94	J. C. Peebles
Insulating Boards	Pressed wheat straw pulp	Rigid slabs	14.5	200	0.365	90	2.74	.....
Sheetrock	Gypsum and sawdust	Rigid sheet between heavy papers	60.7	.....	1.40	90	0.715	A.S.H. & V.E. Guide
Thermax	Shredded wood and cement	Rigid sheet	24.2	200	0.46	72	2.07	J. C. Peebles
Wool Paper Products	Laminated wool felt	Solid pipe covering	24.5	200	0.452	120	2.21	.....
Wool Paper Products	Indented wool felt	Pipe covering	15.0	200	0.337	120	2.97	.....
Wool Paper Products	Wool paper and asphalt saturated paper — alternated	Pipe covering	31.7	200	0.460	112	2.17	.....
Asbestos Paper Products	Corrugated air-cell type	Pipe covering and sheets	13.7	300	0.632	200	1.58	.....
Asbestos Fiber for Underground Conduit Insulation	Willowed asbestos fiber waterproofed	Filling	8.5	375	0.545	300	1.83	.....
Magnesia	85% magnesia — 15% asbestos	Pipe covering and blocks	14.5	600	0.548	400	1.83	.....
Fire Felt	Long brown asbestos fiber and silicate of soda	Pipe covering and blocks	20.4	700	0.685	500	1.46	.....
Asbestos Paper	With imbedded sponge particles 40 laminations per inch	Pipe covering and blocks	30.0	700	0.590	500	1.71	.....
Asbestos Paper	Indented. 26 laminations per inch	Pipe covering	19.1	700	0.665	500	1.50	.....
Vitrified Asbestos Paper	Asbestos paper — treated with vitrifying solution and baked	Pipe covering and sheets	21.6	700	1.20	300	0.83	.....
Rock Wool	Loose	Filling	10.0	1,000	0.270	90	3.70	Bureau of Standards
Rock Wool	Granulated	Filling	9.42	1,000	0.285	156	3.51	.....
Rock Wool	Felted	Blankets	8.2	1,000	0.408	300	2.45	.....
Rock Wool	Felted with metal jacket	Pipe covering	19.4	1,000	0.532	400	1.88	.....
Rock Wool	Molded with clay and asbestos	Sheets	15.2	1,000	0.384	200	2.60	.....
Spun Glass	Fine glass fibers, perpendicular to heat flow	Blanket	5.56	1,000	0.510	400	1.96	.....
Fire Felt	Short white asbestos fiber and silicate of soda	Pipe covering and sheets	39.6	1,000	1.30	500	0.77	.....
Crumbled Aluminum Foil	Crumbled foil and air — 7 layers per 2½ in.	Pipe covering	....	.....	0.680*	500	1.45	.....
Asbestos Fiber Cements	Asbestos fibers only	Cement	66.6	1,000	1.6	200	0.625	.....
Asbestos Millboards	Asbestos pressed	Rigid sheets	60.5	1,000	0.843	86	1.19	Bureau of Standards
Calcium Carbonate	Molded with asbestos	Pipe covering and sheets	23.6	1,000	0.610	400	1.64	.....
Asbestos Fiber Cements	Asbestos and clay	Cement	50.0	1,200	1.2	200	0.83	.....
Rock Wool Cement	Rock wool and clay	Cement	30.0	1,200	1.02	500	0.98	.....
Diatomaceous Earth Bricks	Natural brick cut from earth, heat flow perpendicular to strata	Brick	27.7	1,600	0.92	1,600	1.09	.....
Diatomaceous Earth Blocks	Molded with asbestos, magnesia and clay	Pipe covering and blocks	26.0	1,600	1.06	1,600	0.94	.....
Monohydrated Bauxite	Molded with asbestos and clay	Pipe covering — blocks and bricks	33.0	1,600	1.20	1,600	0.83	.....
Diatomaceous Earth Cements	Mixed with asbestos, magnesia and clay	Cement	30.0	1,600	0.735	400	1.36	.....
Diatomaceous Earth Fillers	Coarse powder	Filler	20.0	1,600	0.98	1,600	1.02	.....
Diatomaceous Earth Fillers	Fine powder	Filler	17.2	1,600	0.89	1,600	1.12	.....
Portland Cement and Calcined Diatomaceous Earth	Mixture — 4 pts. calcined earth to 1 pt. of cement by volume	Poured as concrete	61.8	1,800	2.80	1,600	0.36	.....
Calcined Diatomaceous Earth	Molded and fired	Bricks	38.0	2,000	2.12	1,600	0.47	.....
Calcined Diatomaceous Earth and Clay	Molded and fired	Bricks	42.3	2,500	2.25	1,600	0.44	.....

*Cannot be considered true conductivity, since there is a combination of materials; aluminum foil and air, and a 1-in. thick covering could not be constructed having the same proportionate amount of each material as the seven layers per 2½-in. thick covering.

Tabulation by B. Townshend and E. R. Williams, originally published in *Chem. & Met.*, vol. 39, no. 4, p. 220.



Flow diagram of strong phosphoric acid process

MAKING STRONG PHOSPHORIC ACID AT TRAIL

By WILLIAM C. WEBER
Chemical Engineer
The Dorr Co., Inc., New York City

PIONEERING of a high order has been the dominant characteristic of that vast and ambitious program of chemical fertilizer manufacture upon which the Consolidated Mining & Smelting Co., of Canada, Ltd., embarked three years ago. As a result of this effort there stands today at Trail, B. C., a great new chemical industry with a daily capacity of 375 tons of 100 per cent sulphuric acid, and of 300 to 400 tons of ammonium sulphate, ammonium phosphate and triple superphosphate. The plants there situated entailed an expenditure of $10,000,000 and upwards, cover 60 acres of land, employ about 300 men and consume each day 34,000 hp. of electrical energy.

An article that appeared in *Chem. & Met.* for November, 1931, tersely briefs the significant developments at Trail in the following manner: "A lowly byproduct—sulphur dioxide in smelter fume—and cheap hydroelectric power underlie the whole impressive development. . . . To utilize sulphuric acid from a modern contact plant, a new wet-process phosphoric acid unit was built. To utilize a part of this output, a new synthetic ammonia plant was built. To utilize cheap power, electrolytic cells were selected as a source of hydrogen."

In that article a full description was given of the plants in which the sulphuric acid, hydrogen, ammonia and ammonium sulphate are made. Consequently, this article and one to follow it will deal solely with the production of phosphoric acid, ammonium phosphate and triple superphosphate. Here pioneering and faith in the ultimate outcome were freely displayed, for the conventional type of weak phosphoric-acid process, initially planned, was replaced by a new but promising process which later demonstrated its ability to produce 30–32 per cent P_2O_5 acid direct without evaporation, as against 19–22 per cent P_2O_5 with the older processes.

It might be well to digress for a moment to review the economic advantages of the new process, since the process initially planned, employing a series of thickeners for washing the precipitated gypsum, is widely used as the standard wet process of the industry. It is found that the maximum strength of acid produced by the weak-acid process is 20–22 per cent P_2O_5, as against the 30–32 per cent P_2O_5 acid from the new strong-acid process.

Therefore, when the acid is concentrated to an average strength of 37 per cent P_2O_5, as required by the simplified fertilizer processes to be described in the second article, the weak-acid process requires the evaporation of 250 to 310 tons of water per day when treating 450 tons of rock, as against only about 60–90 tons with the strong-acid process. If 20 per cent acid were made, there would have to be a very large and costly installation of evaporators and boilers, consuming great quantities of coal, an expensive material in isolated Trail, but with 30 per cent acid, a moderate sized evaporator installation suffices and enough surplus byproduct steam is available from the metallurgical operations.

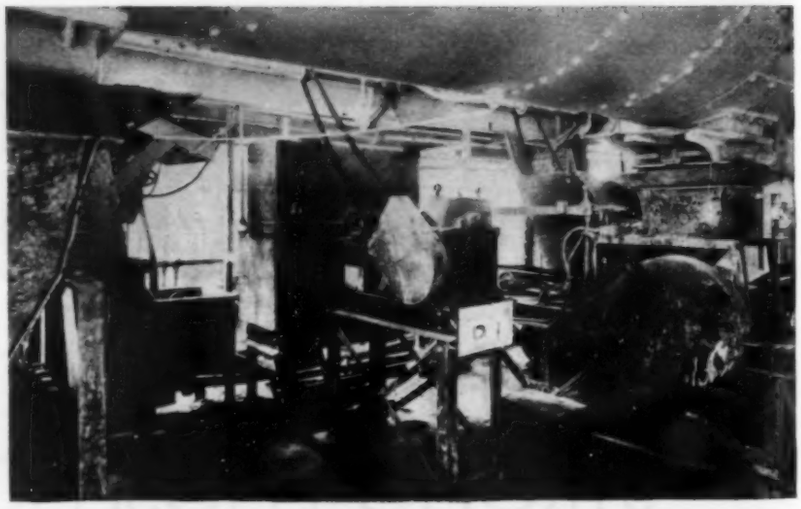
Experience in the past has shown that the organics contained in the Montana-Idaho rock to be used cannot be removed economically by sedimentation. The only other wet-process plant using this rock found it expedient to calcine the rock for the removal of organics prior to acid digestion. But when the strong-acid process is used, it is found that this expensive calcination operation can be dispensed with, and a clear organic-free acid produced. Weak-acid plants in Europe utilizing high-organic African rocks clarify the acid in presses, also a very expensive and troublesome operation.

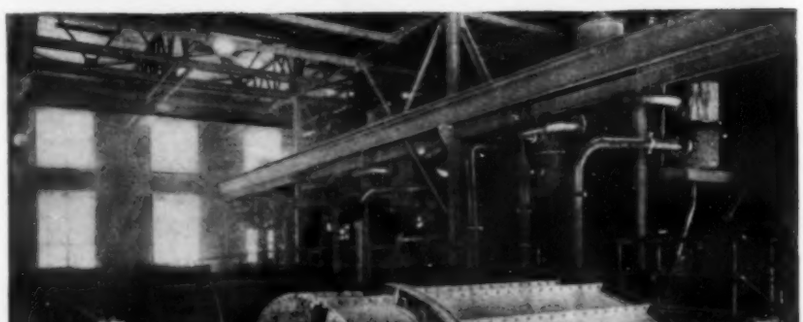
Another factor governing the choice of processes is the cost of buildings. At Trail this would have been a

sizeable item since the plant is probably the largest wet-process plant in the world, employs an expensive and permanent type of construction and is located in a district where severe spells of winter weather are the rule rather than the exception. Here again the strong-acid process is to be preferred for, although the cost of operating a double filtration station is greater than a series of countercurrent thickeners, the filters require appreciably less space.

In addition to the strong-acid process new methods were adopted for processing the acid to ammonium phosphate and triple superphosphate in order to take the fullest advantage of the stronger acid and to make a product of as near ideal physical properties as possible. The processes adopted were devised jointly by the Dorr Co., Inc., and its affiliate, Kunstunger Patent Verwertungs A. G., a patent holding and research corporation for chemical fertilizer processes with headquarters in Switzerland. The Dorr Co., Inc., contracted to supply, erect and initially operate the entire plant exclusive of buildings.

In brief, the acid process is as follows: Phosphate rock from Garrison, Mont., is ground in phosphoric acid solution in tube mills of special construction and the resulting slurry is agitated continuously in a series of agitators with the weak wash solution and the quantity of sulphuric acid required for the complete digestion of the rock. Rock and acid are added in the exact proportions required by accurate interlocked mechanical feeders. The slurry is cooled during agitation. The acid and gypsum are separated on the first of two batteries of rotary vacuum filters, the strong or first filtrate from which is the final product, a strong, clear phosphoric acid containing from 30–32 per cent P_2O_5. The gypsum is washed first with acid and then with water and sent to waste. Through special methods of reaction control and recirculation of a portion of the slurry, the gypsum is precipitated in a crystalline form which may readily be separated and washed in phosphoric acid solutions of much greater strength than had been heretofore possible.





Above: Proportioning equipment including Poidometers for phosphate rock and Howard feeder for sulphuric acid

Below: Strong-acid filters where acid of 30-32 per cent P_2O_5 content is recovered

Phosphoric Acid Plant in Detail

The plant is laid out on the sectional basis so common in metallurgical mills and consists of three parallel, independent sections. The daily rated capacity of the three sections is a total of 450 tons of phosphate rock of 70 per cent tricalcium phosphate content and 350 tons of 100 per cent sulphuric acid. The extraction efficiency is about 95 to 96 per cent, the washing efficiency about 97 to 98 per cent and the overall recovery of P_2O_5 in the form of phosphoric acid is consequently 92 to 94 per cent.

Phosphate rock (32 per cent P_2O_5, 44 per cent CaO, 3.5 per cent iron and alumina and 15 per cent SiO_2) arrives by rail. It is run of mine and contains up to 12-in. lumps. It is reduced to $\frac{3}{8}$ in. at the company's crushing plant at Tadanac, the site of the metallurgical operations. The phosphate plant and other fertilizer units are located at Warfield, a plateau about 400 ft. higher and about one mile distant. After exhaustive study of the relative cost of rail haul, aerial trams, etc., the Consolidated engineers decided on motor haulage. Ten-wheel, 15-ton trucks are used which have been rebuilt to carry 20 tons of phosphate rock at an astonishingly small cost of operation. The rock is stored outdoors and the trucks construct their own piles without additional labor. An underground belt conveyor has been provided to carry the rock either directly to the phosphate plant or to a dryer.

When necessary the rock is dried to about 2 per cent moisture before being delivered by a series of elevators

and conveyors to the multi-compartment bin within the building. Automatic samplers and weightometers provide a continuous record of the rock on hand and ready for milling. The bin is of the catenary type, constructed of steel, and has a total capacity of 700 tons or 1½ day's supply at rated capacity.

Sulphuric acid is manufactured at Tadanac and pumped to the fertilizer plant through a pipe line one mile long. The contact acid plant produces 99 per cent acid but this is diluted to a strength of 94–95 per cent, in order to prevent freezing in winter. At Warfield it is stored in an outside steel tank holding a three days' supply. Within the plant are three storage tanks, one for each plant section, providing 12 hours' supply and furnishing the acid feeders by gravity.

Discharge from the rock bin is to six Schaffer Poidometers which in turn deliver a continuous and weighed amount of rock to six Dorrco acid-resisting tube mills 7 ft. in diameter x 16 ft. long. Phosphoric-acid wash solution from the filters gravitates from a high-level storage tank through a weir box and splitter and thence in part to the tube mills and in part to the acid mix station, to be described later.

Mills Corrosion and Abrasion Resistant

The Dorrco mills are protected against acid and abrasion by, first, a rubber lining cemented in place, then, a layer of wood strips and, finally, a layer of silex blocks, set in special acid-resisting cement. A drum-type feed scoop is employed. The grinding media consist of imported, selected flint pebbles. Make-up pebbles are 4 in. Pebble consumption is 2 to 3 lb. per ton of rock. The amount of weak acid used is roughly 1½ times the weight of the rock and the ground slurry is about 75 to 80 per cent through 100 mesh. This is a coarser grind than permissible in weak-acid plants. As the ground slurry flows from the mills to the agitators in which the reaction takes place, it drops through a bar grizzly for the removal of pebbles and tramp material.

Sulphuric acid is added to the system by three Howard acid feeders, one for each section, constructed of steel and driven from the same variable-speed mechanism as the rock feeders to assure synchronism under all conditions of load. The acid is diluted with the balance of the wash solution in a specially designed mixing head on top of the launder between the third and fourth agitators.

Each reaction section consists of five continuously operated, series-connected agitators. Four of these are Dorr agitators of the combined air and mechanical type, 14 ft. in diameter x 15 ft. deep, while one is a specially designed propeller type, 12 ft. in diameter x 13 ft. deep. The tanks are of wood, lined first with sheet lead and then with acid-resisting brick set in acid-resisting cement. The agitator parts below the solution level or exposed to fluorine fumes are constructed of rubber-covered steel and alloy steel. The agitators are covered and wood ducts vent the fumes to the atmosphere, via a scrubber for the removal of the silica and silicofluorides contained therein.

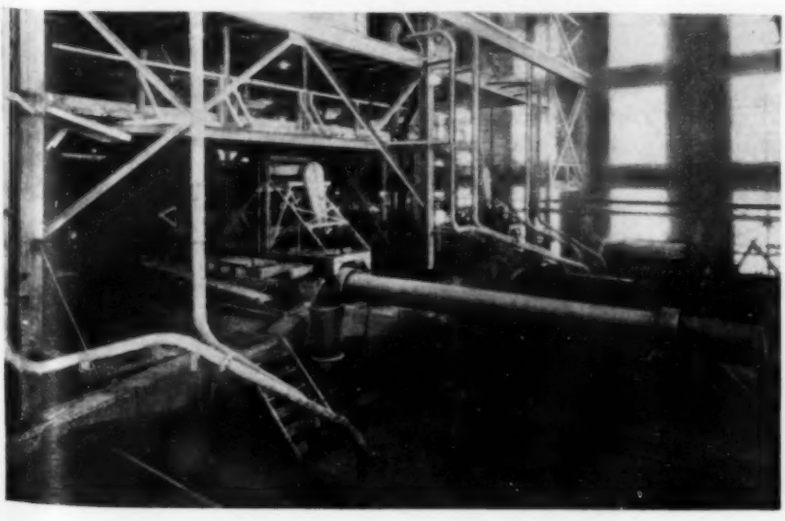
Slurry Cooling Simple But Effective

Due to the smaller quantities of material entering the reaction and the very strong sulphuric acid used there is considerable surplus heat of reaction. To maintain optimum reaction temperatures it was necessary to provide cooling of the slurry. An ingenious and at the same time simple system was developed. It was found that large volumes of low-pressure air would, in bubbling through only a few inches depth of slurry, rise almost to the temperature of the slurry and be saturated with moisture at this temperature. The vaporization of this quantity of water resulted in a considerable cooling effect at only a slight power consumption and with very simple equipment. This operation is carried out in the fourth agitator which is equipped for relatively violent agitation.

Between the fourth and the fifth agitators there is a battery of nine 4-in. Wilfley centrifugal sand pumps, three per section, constructed with rubber-lined casings and alloy-steel impellers. These recirculate a considerable portion of the slurry, returning it to the first agitator through rubber-lined piping. The function of this recirculation is to reduce the supersaturation and to cause the rock to be attacked with relatively low-strength sulphuric acid, a condition which is propitious to the formation of very few new gypsum crystal nucleii and to the building up finally of a smaller number of particles of uniformly large size. Without this important and patented feature it would be impossible to control the crystal structure and to produce in such strong acid a crystal which could be handled on a vacuum filter. The addition of the sulphuric acid at the end of the reaction system facilitates the maintenance of the desired excess SO_4 throughout the system and especially in the slurry going to the filters. This control of SO_4 concentration is of vital importance since variations in either direction, beyond closely prescribed limits, affect the crystal structure detrimentally, lower extraction and result in poor capacity and washing efficiency. It might be added that this same circulation and reaction control system has been applied to weak-acid process plants with marked success.

Leaving the last agitator of the series the slurry consists of strong

Weak-acid filters for final washing of gypsum



phosphoric acid and suspended gypsum, the dilution by weight being between 2 and 2.5 to 1. The two final operations—separating the acid and washing the gypsum—are carried out in a double filtration station. This consists of one battery of four Dorrco vacuum filters, 12 ft. in diameter x 12 ft. face, one per section and one as a spare; and another battery of four filters of the same make, 10 ft. in diameter x 8 ft. face, also one per section and one as a spare unit. These two batteries of filters are connected in series for double countercurrent washing of the cake with repulping in weak acid between the two stages of filtration. Water is applied only for the final wash, since filtrates of different strengths are used for the initial stages of washing. The filters are very special for this work. Shells are constructed of rubber-lined steel and the accessories and fittings are of hard lead, alloy steel or rubber. The filter medium is nitrated silk or Doracid cloth, a nitrated cotton fabric which was developed especially for service in strong, hot phosphoric and sulphuric acids. The development of a filter and filter medium for this work was almost as great an accomplishment as the process itself. Thickeners unfortunately cannot be used because the crystals will not settle properly in such heavy acid.

Recovery of 30-32 Per Cent P_2O_5 Acid

The function of the strong-acid filtration station is to separate the finished acid from the gypsum and to give the gypsum cake one displacement wash. During the cake-forming cycle, a strong filtrate is withdrawn and sent to storage tanks at a P_2O_5 content of 30–32 per cent. The cake, emerging from the slurry, is washed with primary filtrate from the second battery of filters and the somewhat weaker filtrate withdrawn during this washing is pumped to storage tanks and reintroduced into the cycle as diluent in the tube mills and in the reaction agitators. The washed cake is repulped with secondary filtrate from the second battery of filters. This repulped cake flows at a dilution of about 2 to 1 through three 14-ft. diameter x 14-ft. deep mixing tanks, one per section, between the two batteries of filters. These are provided with propeller agitator mechanisms.

From the mixing tank the slurry flows to the second battery or so-called weak-acid filters which give the gypsum crystals their final wash prior to discard. The filtrate which is withdrawn during the cake forming cycle is pumped to a storage tank and thence, after heating, to the wash sprays on the strong-acid filters. Hot water, metered and regulated by a Foxboro recorder-controller is then applied to the cake and the secondary filtrate so formed is pumped to storage and is used to repulp the cake from the strong-acid filters. The cake is discarded. Gypsum is automatically sampled.

Going back over the strong-acid plant, momentarily, a few small yet interesting details might be mentioned. The cooling of the slurry in the next to the last of the reaction agitators results in the evaporation of so much water that about 25 per cent more wash may be applied on the gypsum filters than theoretically possible, one explanation of the unusually strong acid which can be produced. Acid lines of special, flexible rubber hose with pinch valves were found extremely satisfactory though lead pipe and rubber-lined pipe were also used. (For a more complete discussion of the materials of construction requirements for strong phosphoric acid see the article by the writer in *Chem. & Met.* for October, 1932.)

The strong, hot acid is saturated with gypsum and also sodium and potassium fluosilicates. Therefore, any change in temperature, concentration of H_3PO_4 or excess H_2SO_4 may result in very troublesome crystallization in filter cloths, pipe lines, storage tanks, etc. Gypsum scales are controlled by avoiding any excess of CaO over SO_4, by careful control of temperature and by avoidance of sudden changes in H_2SO_4 concentration. Fluosilicate scaling is chiefly a result of sudden temperature or concentration changes and by proper operation and plant design can be largely eliminated. A certain amount of crystallization in the filter cloths is unavoidable, especially with fluosilicates, but this can be effectively handled by regular washing. A hot water wash is used regularly. For removing gypsum a 2 to 3 per cent solution of ammonium carbonate at 35 deg. C. has been found most efficacious. This is circulated through the filters and converts the gypsum to ammonium sulphate and calcium carbonate. This last dissolves quickly when the acid is again applied. The filter washing has been reduced to a simple, rapid, operating routine.

Each filter is provided with two rubber-lined filtrate receivers. The vapor pipe leads to a cast-lead moisture trap and thence to a barometric condenser of the umbrella type. Each condenser is equipped with a vacuum regulating valve which adjusts the vacuum it receives from a central vacuum-pump station. Filtrates are removed from the receivers by full barometric legs sealed in small sumps. Alloy steel centrifugal pumps elevate the acids to the various storage tanks, while the tanks for strong acid are provided with thickener mechanisms to remove mechanically precipitated fluosilicates and some gypsum which deposit after cooling.

The plant is carefully laid out to avoid losses of P_2O_5. Floor drains and equipment overflows lead to a sump which also takes care of filter washings. The pulp is periodically or continuously returned to the process. Only condenser and scrubbing tower water is allowed to go to the sewer. The sewer is provided with a conductivity alarm weir and automatic sampler.

Other Values Available for Marketing

A number of byproducts are available which eventually may be made merchantable. A considerable quantity of silicon tetrafluoride is evolved at the acid mixing head and in the reaction agitators of the phosphoric acid plant. This is withdrawn through the cooling system towers. It decomposes to give SiO_2 and H_2SiF_6. If a market could be developed for this hydrofluosilicic acid and high grade silica, it should be possible to improve the scrubber system and produce close to 5 to 6 tons per day of the acid (100 per cent basis) and 1 to 1¼ tons of silica. The gypsum filter cake now sent to waste contains 30 per cent moisture and amounts to 660 tons per day at rated capacity. It could be used in the manufacture of building blocks and other structural materials or could serve as the basis of further fertilizer operations leading to the production of ammonium sulphate and calcium nitrate.

How the acid produced as has been described is concentrated to 34–37 per cent, depending on the use, and how it is used in the production of triple superphosphate and ammonium phosphate forms the subject of a separate article which will appear in an early issue.—Editor.

Oil Gas Generated by New Process

IN A PAPER given before the American Gas Association at its Atlantic City meeting in October, Alfred Johnson, chief engineer of the Combustion Utilities Corp., New York City, described his company's new "Refractory Screen" oil-gas process which was developed primarily to handle high peak loads in regions supplied by natural gas. He pointed out that in order to secure a proper return on the pipe-line investment, a substantial base load in the high income producing class has to be secured. This involves the need of acquiring house-heating load which, due to the rapid fluctuation of temperature, decreases the load factor with the result that a considerable part of the line investment is called upon to meet peak-load demand. It is obvious that if a proportion of this demand can be supplied at a lower cost by a satisfactory substitute gas, produced in existing idle generating equipment, then spare line capacity can be released for the increased sales resulting from a higher annual load factor.

The process developed is based on the fundamental that carbon liberated in high-temperature oil cracking is sufficient, when properly burned, to supply the heat required for cracking a subsequent and equivalent quantity of oil. The resulting low-gravity gas thus produced from the primary cracking of oil at high temperatures is then enriched to give a final gas of desired calorific value and specific gravity.

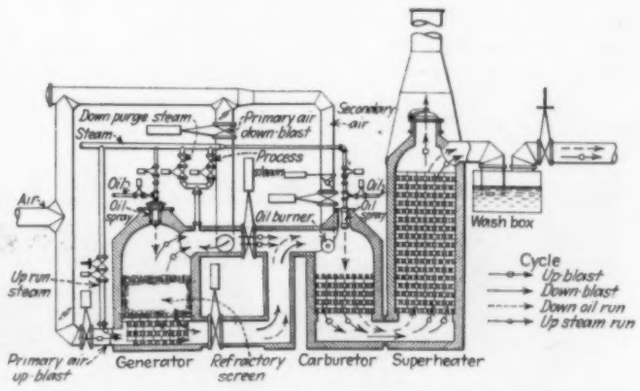
Experiments were carried out first on a laboratory and semi-commercial scale and later in standard water-gas units of increasing size. The accompanying diagram illustrates the set-up finally adopted. The generator grates were removed and replaced by a refractory checker-work on which a bed of small, non-spalling, high-temperature-resistant refractory blocks—the so-called refractory screen—was built up. A water-cooled oil spray was inserted through the generator charging door. An additional air nozzle was provided for down-blasting the refractory bed. A gas connection and hot valve were added between the generator bottom and the carburetor top. Oil burners were provided in the generator and carburetor for heating up purposes.

Operating the Plant

Operation of the equipment is as follows: The generator is brought up to an operating temperature of about 2,000 deg. F. and the carburetor and superheater to 1,400 to 1,500 deg. F. by means of the oil burners. The burners are then shut off and combustion products swept out with a down-steam purge, after which the stack valve is closed and oil is admitted to both generator and carburetor. Process steam is admitted with the generator oil. Fuel oil or oil-tar mixture sprayed into the generator is instantly vaporized and the hydrocarbons are cracked to a permanent gas in passage through the refractory screen. This gas passes through the bottom cross-over pipe to the top of the carburetor and there meets the enriching oil sprayed into the carburetor. The finished gas exits from the top of the superheater to the relief holder through the seal box.

After the cracking period the generator and carburetor oils and the process steam are shut off and the valves shifted to an uprun steam position. Uprun steam is admitted purging the unit free of oil gas and reacting with the excess carbon (over that needed to supply heat) to form blue gas. This operation is followed by an upblast of air which is simultaneous with the start of a secondary air blast in the carburetor and the lighting of the carburetor oil burner. The burner supplements the combustion of primary blast products and assures maintenance of uniform carburetor temperature. The cross-over valves are then reversed prior to a down blast, first with primary air and then with a down steam purge, after which the cycle is repeated.

A mechanically operated set uses a cycle time of three to four minutes while five to six minutes is usual for hand operation. It was found that the control of the unit required but little supervision due to the fact that the generator inherently reaches a temperature equilibrium, producing gas with but little change in calorific value or specific gravity. The absence of clinker and ash promotes constant gas-making rates. The elimination of fuel handling, screening, charging and clinkering is reflected in increased capacity and low labor and maintenance costs. There is no smoke nuisance nor is there any trouble with spalling or fusion of the refractory bed, nor with glazing of the carburetor and superheater checker-work.



Equipment used in Refractory Screen oil gas process

Any tar produced can be collected and separated from the circulating liquor in a conventional tar separator from which it may be pumped to storage. The wet tar or even an emulsion can be returned with the generator oil and be completely processed. Naphthalene scrubbing is not required.

The process has operated satisfactorily in yielding gas ranging from 500 to 1,100 B.t.u. A typical gas of 530 B.t.u. and 0.665 specific gravity contains 8.4 per cent CO, 33.6 per cent H_2, 16.6 per cent CH_4 and 2.0 per cent C_2H_6. Oil consumption per M cu.ft. in a typical case is 6.8 gal. of Bunker "C" oil or 4.95 gal. of Bunker "C" oil and 1.65 gal. of gas oil. The steam requirement per M cu.ft. is 35 lb. Using all Bunker "C" oil with the tar returned, the estimated requirement of total oil is 6 gal. per M cu.ft.

MARKETING AND INDUSTRIAL USES OF CHARCOAL

By R. S. McBRIDE
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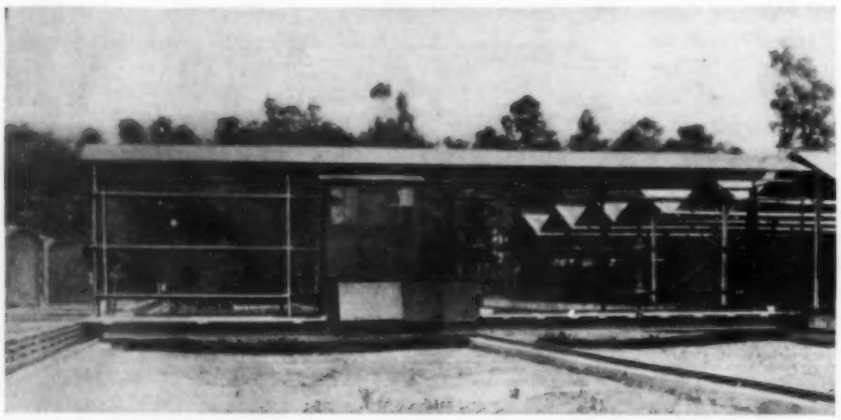

Charcoal transfer car which handles four buggy trains of charcoal from the final coolers at the left to the conditioning sheds at the right

TWO EARLIER articles of this series dealt with the inter-industry relations and technical problems of the hardwood distillation industry while the next, to appear in February, 1933, will discuss the market situation of the hardwood chemicals. Charcoal, which is both a fuel and a chemical raw material, is the subject of the present article, and a particularly vital one since the extent of its use in both fields governs very directly the rate of operation of wood-distillation plants. It is important, therefore, for one to analyze the factors affecting both types of usage, whether his interest is in charcoal itself or merely in wood chemicals.

Charcoal is used as fuel in several ways. From one-half to one-third of the total charcoal production during the past decade has been used as a blast-furnace fuel for the making of charcoal pig iron. The household market absorbs the second largest quantity; and in this field lies the major merchandising problem. A wide variety of uses is made of charcoal as metallurgical fuel other than in the blast furnace. It is employed in the manufacture of "charcoal" tin plate and "charcoal" ingots and blooms. These products are not now made from charcoal pig iron, but gain their names from the use of charcoal at later stages of the metallurgical procedure. Charcoal is also used extensively as a fuel in numerous non-ferrous metal-working applications and in the electric furnace where it gives desirable electrical properties to the charge. It is also an important fuel aiding in the recarburizing of scrap steel during remelting. Its use in portable heaters by tinsmiths and other mechanics accounts for a substantial quantity of the fuel in the aggregate.

In briquetted form charcoal finds extensive application in the railroad dining car kitchen, and to a lesser degree in hotels and for heating refrigerator cars in cold weather. Some charcoal briquets are used for household fireplace fuel.

Chemical manufacturers use charcoal as a raw material for carbon bisulphide, carbon tetrachloride, sodium cyanide, and a number of other carbon-containing compounds. Charcoal is also an important constituent of industrial materials such as black powder. All of these direct industrial uses are, however, a small factor in the total use of charcoal. According to one estimate made by the Department of Commerce, the total chemical usage in pre-war years was only 3 per cent of the total charcoal consumption. Under present conditions, partially due to the shrinkage in total use, the chemical applications of charcoal are much more important relatively.

Application of charcoal in mixed feeds for poultry and livestock also has grown, both in absolute quantity and in percentage of total charcoal. The limitation of use is partly lack of fundamental facts regarding the value of charcoal in feeds, and partly at present time in the relatively low price of grain.

Precise information regarding charcoal consumption in different industries has never been gathered by anyone, so far as the present author can learn. An effort has been made, however, to prepare a composite estimate approximating as nearly as possible the distribution of charcoal in one recent year. The resulting estimate appears in Table I. It will be noted that the household and briquet *fuel* uses are almost exactly equal to metallurgical and other industrial applications. This relationship actually does prevail as all three of the principal agencies marketing charcoal have agreed.

Charcoal-iron manufacture has a more important influence in determining the whole economic trend of wood distillation than any other single factor. When there is a large demand for charcoal iron, the wood distillers associated with that industry are active, using in their own blast furnaces substantially all of their own charcoal, and even becoming important purchasers from other wood chemical plants. Under such circumstances the demand for charcoal is stabilized and the price is correspondingly firm. When the charcoal-iron blast

furnace shuts down, there is at once created a very large potential surplus of charcoal. The common consequence is cutthroat competition, price wars, and a completely disorganized charcoal market.

Charcoal pig iron was formerly an extremely important metallurgical product in the United States. It is still regarded as essential for the making of rolls for steel-rolling mills and for certain other types of castings in which fine grain, ruggedness, abrasion-wear resistance, and good surface are essential. Recently, charcoal iron has found a new application of this character in the making of glass molds, especially those used for automatic-machine manufacture of products such as pressed tableware.

Coke Iron Competes With Charcoal Iron

Charcoal iron in most applications is competitive with coke iron; only a few users find the former really essential. Hence with the very low prices (below $15 per ton) recently prevalent for pig iron, the price premium of approximately $5 per ton for charcoal iron has been a very important factor limiting its use. This has accelerated the decline in charcoal consumption in blast furnaces, as evidenced in Table II. It will be noted there also that there is a close parallelism between the decline of charcoal used in this major application and the total production of charcoal.

Substitution of coke iron for charcoal iron has in some cases been accelerated by the addition of alloying elements. Only a very few types of castings cannot be made equally well with coke iron, especially if slight alloy addition is practiced. Under these circumstances it can be readily seen how uncertain is the future outlook for that very large part of the total charcoal production which has formerly been absorbed by the blast furnace operators. The significance of this situation with reference to the price of charcoal will later be evident.

Charcoal is used in the household for a variety of purposes. In many homes of the poorest class it is the only fuel available, serving both for cooking and heating. Here charcoal is said to have little competition except from wood. In the better-class homes charcoal is occasionally used for broiling. Some merchandising groups have developed charcoal grills for this purpose which can be used in a fireplace or in the oven of a cooking range. In a far larger number of homes charcoal is used merely as kindling, with only wood as a competitor. In a limited number of homes charcoal is essentially a luxury fuel for fireplace use.

Merchandising of charcoal for household use is probably the greatest unsolved problem of the wood distillation industry. Success in this direction has attended the efforts of only a very few charcoal producers. And oftentimes, through cutthroat competition, their good results in building markets in certain communities have been altogether destroyed by rival producers.

Successful merchandising of charcoal in any community demands initially an intensive campaign, both with the users of the charcoal and with the distributing dealers. Apparently the result depends more upon the diligence of the dealers or the campaign manager and on proper selection of sales territory than upon any other considerations.

It is common for charcoal producers, or groups of such producers working through a single sales company, to have an extended staff of wholesale dealers. The most successful charcoal merchants seem to be those who give substantially all of their time and attention to this fuel. Where such a dealer by diligent and continuing effort has developed a good group of retailers, there is a small but rather secure margin of profit to him until dumping of charcoal by other producers or their dealers begins. Unfortunately for the industry as a whole, and particularly for the wholesale dealers, this dumping has extended throughout practically all of the territory that is reached by charcoal in any significant quantities.

Merchandising Chiefly Through Cooperatives

The bulk of the hardwood charcoal made is marketed through one or another of the cooperative marketing companies owned and managed by groups of neighboring producers. The Manufacturers Charcoal Co., the oldest of these cooperatives, serves a large number of the producers in both the western Pennsylvania and the Catskill districts. The Western Charcoal Co., operating from Chicago headquarters, takes much of the charcoal marketed from Michigan, including a surplus production of metallurgical companies which normally use their own output. Recently an effort has been made to establish similar cooperation among Southern producers. Competition between these marketing agencies is very keen. Except in times of restricted charcoal supply, when prices rise above normal, marketing often takes place at such great distances from the point of production that the freight paid consumes a very large part of the price received at the point of delivery.

Some of the distributing groups, seeking to avoid this disturbing competitive relationship, have made proposals for more sound merchandising practice, but the results thus far achieved appear to be negligibly important. As a consequence, in many distributing areas where charcoal might be successfully marketed for both household and industrial usage, the dealers have been bankrupted

Table I—Estimated Distribution of Charcoal by Uses*

	Million Bushels
Charcoal-iron blast-furnace fuel	13.3
Household fuel	10.5
Briquets, largely used as fuel	3.7
Metallurgical uses: Charcoal plate, charcoal ingots, billets, case hardening, etc.	5.0
Non-ferrous metallurgy	1.5
Electric-furnace fuel (and reducing agent)	0.4
Carbon bisulphide, carbon tetrachloride, sodium cyanide, and other chemicals	3.5
Black powder	0.2
Carbon products, electrodes, brushes, etc.	0.1
Stock and poultry feeds	1.0
Activation, decolorizing and deodorizing, acetylene-cylinder filling, gasoline and solvent absorbent, as pigment, in insulation, and miscellaneous uses (by differences)	1.6
Total 1929 production	40.8

* Estimated by the author largely on basis of 1929 conditions.

Table II—Charcoal Production and Its Use in Blast Furnaces

Year	Charcoal Production,* Million Bushels	Use in Blast Furnaces,† Million Bushels
1923	43.0	25
1924	....	20
1925	40.4	20
1926	....	16
1927	39.2	17
1928	....	14
1929	40.8	13
1930	....	9.6
1931	22.0	4.6
1932 (est.)	14.5	2

* Charcoal production figures from Census of Manufactures, except 1932 estimate by author.

†Blast furnace figures from American Iron and Steel Institute, except 1931, based on charcoal iron production, and 1932 estimated by author. The use of charcoal in the blast furnace varies from 90 to 100 bu. per long ton of pig iron made. From Census returns one would infer that charcoal is valued at approximately 9c. per bushel on the average at the blast furnace.

by cutthroat competition, and sales are suffering seriously.

Hardwood charcoal made in wood-distillation plants has two important external competitors. One of these is charcoal made from pine wood by a small number of plants in the far South. In recent years 20 to 25 such establishments have made annually 1½ to 3½ million bushels of softwood charcoal.

In times of normal business the second outside competitor, the kiln or pit-plant operator, is an unimportant factor except locally. From 1920 to 1930 such plants, only 10 or 12 in number, rarely made altogether as much as 1½ million bushels in a year; but during the past three years they have become vastly more important. A considerable number of farmers, without a cash crop, have turned to their wood lot as a source of cash income, making both hardwood and softwood charcoal by the crudest of pit methods and marketing their products at prices ruinous to the nearby competing hardwood distiller. No statistics are yet available to indicate the magnitude of these operations, but it has been estimated by some in the industry that there are several hundred such small pit operators. It is certain that their influence on the market price for charcoal has been extremely important, even though their total production may not have exceeded 3 or 4 million bushels in any single year.

Fine charcoal, from 10 to 15 per cent of the total production, is inevitably formed and is usually separated from the lump when the latter is to be sold or used other than in an affiliated blast furnace. Very limited market for the fines is found; they are usually burned under boilers or retorts, generally mixed with sawdust, bituminous coal or other fuel.

The marketing of sized fine charcoal is usually carried out by firms specializing in this commodity. They buy some material in the fine form, but also purchase and crush considerable lump. The customary package for fine sized charcoal is a paper-lined burlap bag, holding 50 lb.

Much fine charcoal is used in mixed feeds. There has been a growing usage in recent years in the chemical industries where it is used for decolorizing, deodorizing and clarifying purposes. To some extent charcoal without activation is competitive with activated carbons. In at least one case a substantial market for activated charcoal has been developed. This is used in laundries and in commercial water purification, as well as in the chemical uses above cited. Several city-water supplies are treated with such charcoal to correct the color, odor and taste, especially those undesirable effects of certain algae.

Charcoal Rarely Sold on Specifications

Quality of charcoal is hard to define. In very few cases is it sold on specifications. The usual guarantees relate only to the *actual* weight per bushel and the percentage of contained volatile matter. Regardless of the actual weight per bushel, it is a trade custom to sell charcoal on the basis of 20 lb. per bushel, or 100 bu. per short ton.

A typical analysis, on a dry basis, of high-grade charcoal is: fixed carbon, 84 per cent; volatile matter, 14 per cent; and ash, 2 per cent. Such charcoal will commonly contain not more than 0.05 per cent sulphur; it should be delivered with a moisture content not materially greater than 3 per cent; and the heating value is approximately 13,500 B.t.u. per pound of dry weight.

Some of the principal chemical users of charcoal have found by experience that certain types give superior performance in their applications. As a result their orders require special attention, and result in a careful selection based rather on experience than on any quantitative specification. The reactivity of a charcoal is, for example, important; but so far as is known to the author there is no purchase specification that undertakes to define this characteristic in a numerical fashion. In most cases where charcoal is used as a reducing agent, the presence of volatile matter is not objectionable; but where it is to be used as a raw material in chemical reactions, the presence of hydrocarbons is not desirable, because the hydrogen present tends to reduce the efficiency of reaction and may result in greater consumption of other reacting chemicals.

Table III—Typical Unit Costs of Bagged Charcoal

	Cents per Bushel
Charcoal, f.o.b. plant (5-10c.)	7
Freight (2-8c.)	4
Sales commission	1
Wholesale bulk price	12
Bags @ 1c. each	3- 6
Bagging @ 1c. each	3- 6
Wholesale bag price	18-24
Wholesaler's margin (6-12c.)	9
Cost to retailer	27 33

Where available charcoal contains more volatile matter than is desired in the chemical usage, it is common to reduce the volatile matter content by "glowing." This operation consists merely in a partial burning of the charcoal under conditions of restrained draft, occasioning volatilization and combustion from the charcoal of the residual volatile matter.

Charcoal Costs Influenced by Byproducts

Cost of charcoal is hard to determine in any individual plant, because all manufacturing operations in the multiproduct business are susceptible of a variety of cost allocations. It is usual to keep plant costs on the basis of either dollars per cord of wood carbonized, or cents per bushel of charcoal made, or dollars per ton of pig produced.

The major items of plant costs are for: Wood, $2 to $7 per cord (see preceding article); fuel, usually the equivalent of about 1,000 lb. of bituminous coal per cord processed for the retort plant, boiler plant, and chemical plant, not including refinery; labor, 0.5 to 0.7 man-days per cord for a plant not including refinery; water, 12,000 to 15,000 gal. per cord processed; power, about 15 kw.-hr. per cord; and capital charges.

Commonly the investment in a modern plant is from $4,000 to $5,000 per cord of capacity without a methanol refinery. Including a refinery often extends the investment to $6,000 per cord of daily capacity or even more. Many of the older plants represent much less investment than this; and in all works costs one must, of course, take account of the allowances which should be made both for depreciation and replacement.

As a credit against the gross cost so figured, one has

the income from chemicals and minor-product sales to deduct before calculating the cost of charcoal. When all of these items are calculated on the basis of cents per bushel of charcoal (about 50 bu. per cord is a common yield) one has a wide range of figures for the industry. Some plants appear to have a net cost of lump charcoal as low as 6 to 8 cents per bushel; but others certainly have costs of 12 to 15 cents, even assuming practical capacity operation for the most of the year.

Blast Furnace Use Demands 4-5 Cent Price

For use in a blast furnace charcoal has commonly been charged to the furnace department at 7 or 8 cents per bushel. Approximately a ton, 100 bushels, is used per long ton of pig iron made; and at the charcoal price indicated the total cost of charcoal pig iron f.o.b. its furnace, including sales commission, is approximately $19.50. As indicated above, to be more effectively competitive with coke iron the charcoal pig should be salable at $16 to $17 per long ton. On such a basis credit for the charcoal could not exceed 4 to 5 cents per bushel.

Charcoal sold in a market that is not subject to dumping or cutthroat competition should net the producer from 10 to 15 cents per bushel f.o.b. his plant after payment of freight and sales commission. The price so obtainable depends somewhat on economic conditions, as one would expect. The actual experience in one large trade territory well illustrates this fact. When blast furnace operation was reasonably regular the producers netted f.o.b. their plant about 15 cents per bushel on the average for "surplus" charcoal sold. Mere closing down of the furnaces so increased market competition that the average net dropped to 12 cents per bushel. The general business depression had forced this price down further to 10 to 11 cents in 1932; and price cutting during the Fall made further cuts to 8 or even 6 cents net.

When a charcoal producer uses a substantial portion of his output in a blast furnace, and charges this against the furnace at 5 cents per bushel, he generally figures that he must sell at 10 or 12 cents per bushel nearly an equal quantity in order properly to meet average total costs, including proper capital charge and profit on his charcoal plant. When all of the charcoal produced is sold, then a lower average return than this 10 or 12 cents obviously suffices to give equally profitable operation, assuming equally favorable investment and operating conditions. This latter assumption is, however, not always safe, since the plants associated with blast furnaces because of their larger size usually operate at lower average unit cost.

Cost in Bags

The retail unit for charcoal used in the household is a paper bag. Several sizes are "standard" in different territories. Commonly the bags range from three to six to the bushel (20 lb.). The major elements which enter into the cost of a bag of charcoal under certain typical Midwestern conditions may be summarized as in Table III. Of course, wide variation in unit costs exists; the summary should, therefore, be regarded as typical only for certain localities when competition is keen but not of cutthroat nature.

It will be apparent then that, typically, the cost to the retailer of charcoal is 5½ to 9 cents *per bag*. If excessive competition enters, as recently, 50 cents a dozen for small bags or $1 a dozen for large bags is not an uncommon offering price to attract retailers from one source of supply to another. The retail price is usually from 8⅓ to 12½ cents for small bags (six to the bushel) and 15 to 25 cents for large bags (three to the bushel). Thus the retail mark-up is 3 to 6 cents per bag and the retail price becomes 6 to 12 times as much as the f.o.b. price at the producer's plant. It is evident, therefore, that one of the major problems of the wood-distillation industry as a whole is to be found in these cost and price relationships.

The Future of Charcoal

To forecast for this industry is highly dangerous. A few generalizations are, however, apparently justified.

1. The hardwood distillation industry will grow or shrink essentially as it finds, develops, and stabilizes markets for charcoal.

2. Cutthroat competition must be eliminated or the natural consequence of throat cutting will follow—commercial decease.

3. Industrial non-fuel uses of charcoal are important and new uses of this character may be developed. Although, alone, they offer no prospect of being sufficient for permanent profit in the industry.

4. The greatest prospect for future development of non-metallurgical charcoal lies in properly nurtured household markets.

5. Among metallurgical uses the application of charcoal to the making of charcoal pig iron is prospectively most important in size. This market is, however, among the least profitable, as competition between charcoal iron and coke iron appears to offer no chance for charcoal if charged to the furnace at more than 5 cents per bushel.

6. Development of substantially wider markets for charcoal iron can probably come only through narrowing the price premium charged for charcoal iron from $5, which has previously prevailed, to $2.

7. Competition between hardwood charcoal and both pine and pit-burned charcoal (hard and soft wood) is now keen in many areas, but is likely to be reduced if saleable agricultural crops other than wood become available.

8. The spread between f.o.b. plant price and retail price of charcoal in bags for household use is far too wide to permit rapid development of this market. The correction of these price relationships would perhaps subordinate all other economic problems, or even eliminate them for the industry as a whole.

9. The profit margin of the charcoal business is at present so narrow as not to offer any attraction for new investment in the wood-distillation industry until radical change in the general economic relations of the business take place.

10. The extent to which methanol, calcium acetate, acetic acid and other chemicals are made from wood will depend essentially on the marketability of charcoal. Few plants will be able to afford to operate as chemical works unless the price obtainable for their charcoal output is satisfactory, since these chemicals are obtainable from synthetic sources at prices approximately equal to the prevailing market for wood chemicals.

Designing Heads for TANKS and HEAT EXCHANGERS

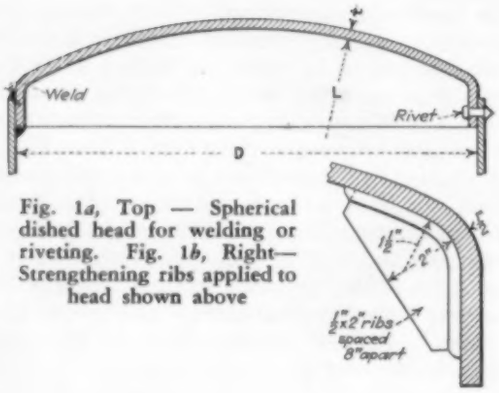

Fig. 1*a*, Top — Spherical dished head for welding or riveting. Fig. 1*b*, Right—Strengthening ribs applied to head shown above

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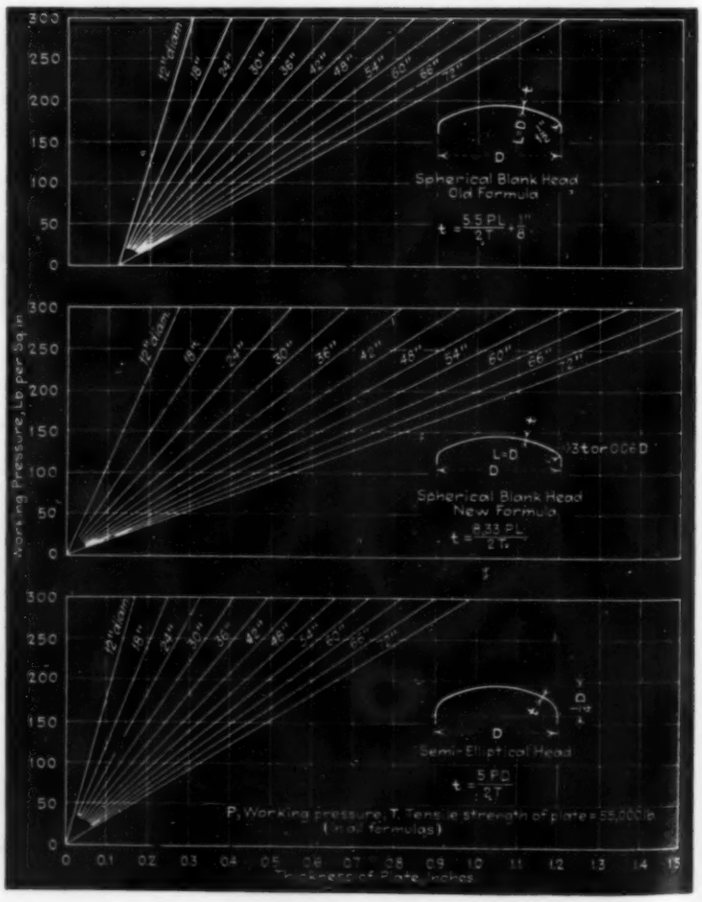
With higher pressures a definite trend in chemical processing, design assumes increasing importance. This article and two to follow it will crystallize in readily usable form the author's broad experience in all phases of head design for pressure vessels

INSPECTION of some of the many kinds of heads, or covers, of pressure vessels in the chemical industries impels one to the belief that the design of this detail is largely of the kind that has been designated, "By guess and by gosh." The heads are the most important elements of a pressure vessel, yet one occasionally sees an installation that bears evidence of care in the design of the shell, but indifference, or perhaps an excessive optimism, in the design of the heads.

An amusing example of the kind came to my attention a few years ago. The apparatus was a heat-exchanger of rectangular form with top and covers curved or dished, and the sides stiffened with steel angles to withstand the pressure. The bottom, however, was a flat, unreinforced plate and was probably deemed of little importance since it was out of sight. The "design" of the bottom apparently was inspired by the maxim, "What you don't know, or see, won't hurt you." Just prior to my visit the bottom had come out of the exchanger, flooding a considerable portion of the landscape with oil. Had the fluid been a vapor or a gas, the exchanger might have been converted into a skyrocket. I hasten to add that the incident was not amusing to the operator.

The art of fusion welding is one of the most important developments of the past generation. Its full importance can be appreciated only by men who have had much experience in the design and fabrication of riveted vessels and structures. Naturally, the tide carried in a horde of manufacturers of the "bootleg" variety to whom a pressure vessel is perfectly safe—and capable of many years of service—if it does not burst in their faces on the testing floor. Happily, state, municipal and other codes are eliminating the "bootleg" welder from the pic-

Fig. 2—Plate thickness for blank heads for various pressures



ture, and the buyer is learning that the cost of the highest skill and the best of equipment and material is insignificant when compared with the possible cost in life and property of the failure of a pressure vessel.

Before the advent of fusion welding, the heads of pressure vessels were riveted to the shell through a flange forming the periphery of the head. The dished portion of the head is pressed or spun to a spherical shape having a radius equal to the diameter of the shell; and the flange is formed tangent to a small "knuckle" curve whose minimum radius is usually 1.5 in. A cross-section of the head appears in Fig. 1*a*, in which one side is shown riveted and the other side welded.

Until a few years ago, the design formula for this kind of head, as applied to steam boilers, was $t = 5.5\ P\ L/2\ T + \frac{1}{8}$ in., where t is the thickness of plate, P the allowable pressure in pounds per square inch, L the radius to which the head is formed, and T the ultimate strength of the plate, 55,000 lb. per square inch being the minimum. For thin plate the arbitrary addition of $\frac{1}{8}$ in. is a large percentage of the total, while for very thick plate it may be comparatively unimportant. Heads containing manholes were made $\frac{1}{8}$ in. thicker than the plain heads. At present the accepted formula is $t = 8.33\ P\ L/2\ T$, with an addition of 15 per cent, or not less than $\frac{1}{8}$ in. for manholes. It is further specified that the knuckle radius be not less than $3t$ or 6 per cent of the diameter of the shell. As shown in the graphs of Figs. 2 and 3, the new formulas give much thicker heads than the old formulas—the differences increasing with the increase of diameter. The new formulas attempt to reduce the high stress at the knuckle or corner curve. Strain measurements of heads designed according to the old formulas have shown stresses in the knuckle that exceeded the yield point of the metal; and a number of failures have attested to the dangerous condition of this element after the lapse of time.

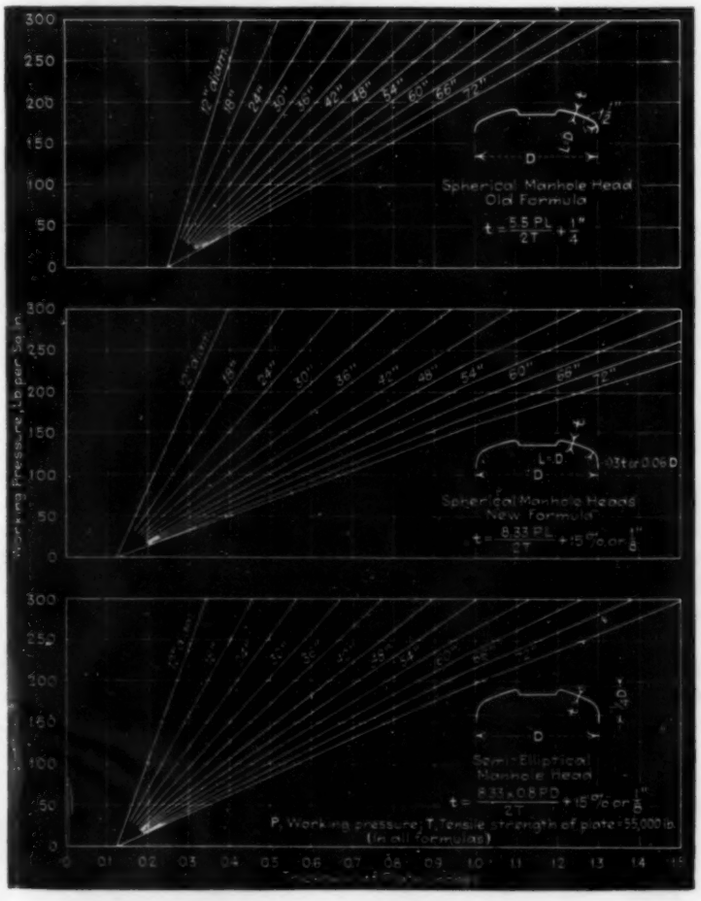
Besides the simple tensile stress to which all curved pressure vessels are subject, there are transverse stresses due to the changing curvature, in which respect a head of this kind is in somewhat the condition of a beam with restrained ends. There is a point a little beyond the knuckle in the direction of the center of the head where the transverse stresses pass through zero and change sign; that is, a point of contra-flexure where tensile stress gives way to compressive stress. The knuckle is rather like a curved cantilever in which the inside fibers carry high tensile stress while the outside fibers carry compressive stress of somewhat less intensity because the neutral axis of the section is nearer the inside (tension) fibers, this condition resulting from the sharp curvature. Were the flange and the knuckle unyielding, the central portion of the head would behave as a sphere under apparently simple tensile stress; but there *is* yielding, and the resulting change of curvature produces transverse stress—tension in the outer fibers and compression in the inner fibers.

Were the high stress the only concern, things might not be serious, but in addition to the high stress there is flexing at the knuckle with every variation of pressure, so it seems that these heads are foredoomed to failure because the number of flexings is limited. Heads of this type that have failed were found to have been cracked completely around the inside of the knuckle—the crack obviously of long standing. The fact that the crack is inside and generally filled with scale makes something more than a casual inspection necessary for its detection.

If there is a question of the safety of an existing head of the old style, it can be made safe by welding ribs to the inside of the knuckle as shown in Fig. 1*b*. By thus increasing the section modulus through the knuckle to twice that of the plate alone, thereby doubling the resistance to bending, the head will be made safe. The desired result can be accomplished with ribs of the same thickness as the head, projecting inwards four times the thickness, and spaced 16 times the thickness. For example: a head of $\frac{1}{2}$ in. thickness should have ribs $\frac{1}{2}$ in. thick, 2 in. wide, and spaced 8 in. apart, which arrangement will have a section-modulus $2\frac{1}{2}$ times that of the plate alone.

The kind of head under discussion is only a segment of a sphere, and when made of thin plate tends, with a portion of the end of the shell, to form a sphere thereby imposing a stress in the end of the shell that is frequently overlooked. The stress along a meridian of the head has a component along a radius of the shell, which produces a compressive stress in the end of the shell of a magnitude depending on the diameter and the pres-

Fig. 3—Plate thickness for manhole heads for various pressures



sure. For example we shall use the head shown in Fig. 4 which, unfortunately, has been too common in practice but which for the purpose of illustration is useful because it is not complicated by the knuckle-curve. All calculations in this article will be made with a slide rule and results are to the nearest value of the second or third place.

The common practice for determining the thickness of this head was the use of the old boiler-head formula, and, for 100 lb. per square inch was ($5.5 \times 100 \times 48/2 \times 55{,}000$) + $\frac{1}{8}$ in. = 0.365 in., say $\frac{3}{8}$ in., while the thickness of the shell, with a joint efficiency of 75 per cent, is $5 \times 100 \times 48/2 \times 55{,}000 \times 0.75$ = 0.29 in., say $\frac{5}{16}$ in.

Head Design Largely Empirical

It should not be thought that because the practical design of these heads is simple, that the stresses are equally simple. As a matter of fact the stresses in the conventional bumped head, with knuckle curve and flange, are quite complicated and any attempt to account for them all would be extremely difficult, if not impossible. As with many problems in engineering, the method of design is largely empirical and includes a so-called factor of safety that presumably allows for the unknown factors.

An example of the complexity involved is the design of the cylindrical shell of a pressure vessel, such as a steam boiler. The popular impression is that the stress is simple tension. In fact, rolling the steel plate to its circular form stresses it far beyond the yield point, putting the outside fibers in tension and the inside fibers in compression. The deformation of the fibers of a 36-in. shell with $\frac{1}{2}$-in. plate is about 12 times that corresponding to the elastic limit of the steel; that is, as found by the common equation, Deformation = Stress/Modulus of Elasticity.

When the fluid pressure is applied to the shell there is a reduction of the compressive stress in the inner fibers and an increase of the tensile stress in the outer fibers. Also, the stresses are complicated by the departure of the shell from a true circle, which sets up high transverse stresses. Furthermore, because of its circular form, the neutral axis of the plate does not coincide with the median line (it is nearer the inner fibers), which changes the proportionality of stress in the region under transverse stress. The circular pressure vessel with its approximately spherical head, while in appearance a most simple piece of apparatus, is the most illuminating example I can at present submit for the justification of the factor of safety in engineering design.

At this point it may be well to discuss some of the elastic properties of a ductile material such as steel, together with the mechanics of stress of pressure vessels. A particle in the wall of a thin cylinder or pipe, which has closed ends and is under fluid pressure, is subjected to three stresses: tangential, longitudinal, and radial. The tangential stress is that tending to burst the shell longitudinally; the longitudinal stress is that tending to burst the shell transversely, or along a girt seam; and the radial stress is the direct compressive stress due to the pressure. A bar under tensile or compressive stress, within the elastic limit of the material, lengthens or shortens by an amount depending on the magnitude of the stress. With the longitudinal deformation comes a lateral or transverse deformation—contraction in the case of tensile stress and swelling with compressive stress. The ratio of lateral to longitudinal deformation is known as Poisson's ratio, and for steel is generally taken as 0.3; so for a longitudinal deformation of 0.001 in. the lateral deformation is 0.0003 in.

A workable theory of the elastic failure of a ductile material is that of the French scientist, Saint Venant. In this theory strain in one plane is influenced, plus or minus, by strains in perpendicular planes. In Fig. 5 is shown a particle in the wall of a tube whose ends are closed and which is subjected to internal fluid pressure. The letters S_t, S_l, and S_r indicate the tangential, longitudinal, and radial stresses respectively. According to the theory of Saint Venant, failure of a ductile and isotropic material (a material whose properties are the same in all directions, a condition which is assumed for steel) occurs with maximum strain, which may or may

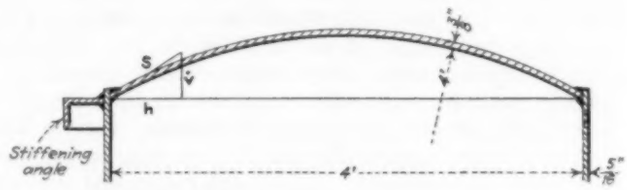


Fig. 4—Plain spherical head of doubtful value, useful chiefly for illustration of stresses

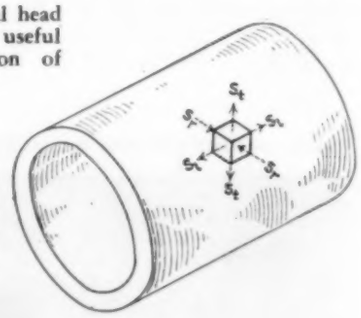


Fig. 5 — Stressed particle in a tube, illustrating the Saint Venant theory of elastic failure

not be proportional to the maximum stress. For example, referring to Fig. 5, the pressure in the cylinder produces stresses and strains in the directions of the arrows. The deformations in the direction S_l, however, is reduced by the stress S_l, but is increased by stress S_r by amounts that are the products of the apparent strain (stress divided by 30,000,000 for steel) and Poisson's ratio. For a cylinder under an internal pressure of 100 lb. per square inch, producing an apparent tangential stress of 11,000 lb. per square inch, the longitudinal and radial stresses are 5,500 and 100 lb. per square inch respectively. The tangential stress that would produce the resultant strain, however, is 11,000 — (0.3 × 5,500) + 0.3 × 100 = 9,380 lb. per square inch, or 85 per cent of the stress found by the design formula, $P\,D/2\,t$.

It is not customary to assume, because there is a reduction of strain, that there is a corresponding reduction of stress, in spite of the fact that stress and strain are related as cause and effect. For instance, a rod with a weight hung from it is under a certain longitudinal stress and strain. By applying a lateral, or perpendicular, compression to the rod the longitudinal strain is increased. The load, however, has not been increased. But by the theory that failure results from maximum strain the effect is the same as an increase of load, or

stress. The discussion of this point has much the flavor of the argument over tweedledee and tweedledum. While the actual strain in the shell of a pressure vessel is less than the apparent strain, designers do not always take advantage of this fact; and codes governing pressure vessels do not permit them to do so. I might state in passing that failures of engineering apparatus and structures do not result from taking advantage of such things as the Poisson-ratio effect—they result from ignoring important fundamentals.

The foregoing example gave a maximum strain of less than that found by the common hoop formula. A case in which the actual strain is greater than thus found is one in which a test is made to determine the pressure required to make a gasket joint tight against fluid pressure. A

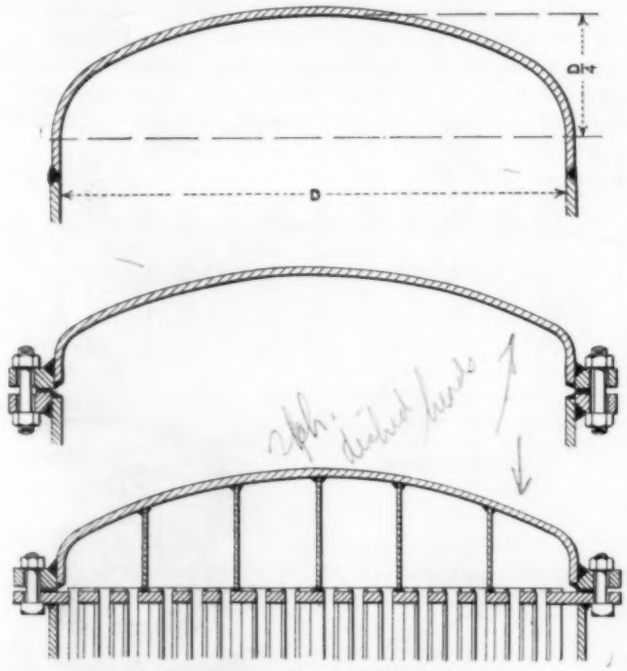


Fig. 6—Butt-welded, semi-elliptical head
Fig. 7—Head of Fig. 6 applied to a flanged vessel
Fig. 8—Baffled elliptical head for heat exchanger

cylindrical shell with a closed bottom and a machined flange at the upper edge, fitted with a gasket and a cover, is placed in a test-machine that exerts a compressive force on the cover while a fluid pressure is applied to the interior. By noting the total force exerted on the cover at the instant when the first leak occurs, and subtracting from it the total fluid pressure in the cylinder, the excess of gasket pressure is determined. The wall of the cylinder in this case is under a longitudinal compressive stress as well as a hoop and a radial stress. If the excess of gasket pressure is such as to impose a stress of 2,000 lb. per square inch in the wall of the cylinder, then the product of this stress and Poisson's ratio, or 0.3, is added to the tangential, or hoop, stress and the radial stress in order to obtain the resultant strain. If, as before, the apparent tangential stress is 11,000 lb. per square inch, and the fluid pressure is 100 lb. per square inch, then the tangential stress that would produce the resultant strain is $11,000 + (0.3 \times 2,000) + 0.3 \times 100 = 11,630$ lb. per square inch, or 6 per cent more than the apparent or one-dimensional stress. In cylinders under low pressure the radial stress is negligible, but under high pressure and in small diameters it may be a considerable factor.

Returning to Fig. 4 we find that the apparent stress along a meridian of the head can be resolved into two components, one vertical and the other horizontal, represented in the figure by v and h. The stress, S, is the same as in a sphere of 48-in. radius, or a cylinder of 48-in. diameter, and for 100 lb. pressure is $48 \times 100/2 = 2,400$ lb. per square inch. With the radius of the head equal to the diameter of the shell, the direction of tangent, S, is 30 deg. from h, and the magnitude of h is $2,400 \times \cos 30 = 2,080$ lb. per linear inch. By the maximum-strain theory of Saint Venant, the equivalent stress in the cover is $2,400 - 0.3 \times 2,400 = 1,680$ lb. per linear inch and the horizontal compression, h, is $1,680 \times 0.866 = 1,455$ lb. per linear inch. Whether to use the maximum principal-stress of Rankine or the maximum principal-strain of Saint Venant in the design of pressure vessels must be decided by the designer from a consideration of the conditions or of the codes. For the case in hand we shall assume that the maximum apparent stress is the determinant and the compressive force is 2,080 lb. per linear inch. The total compression is then $48 \times 2,080 = 99,800$ lb. Opposing this force is the fluid pressure over an area that varies with the pressure and with the diameter of the shell. Assuming that 3 in. of the end of the shell carries the compressive force, then the opposing fluid pressure is $48 \times 3 \times 100 = 14,400$ lb., which, deducted from the compressive force, leaves a net compression of $99,800 - 14,400 = 85,400$ lb. This compression is resisted by the two sides of the shell and produces an apparent stress of $85,400/2 \times 3 \times 0.3125 = 45,500$ lb. per square inch. Tests of vessels with heads as shown in Fig. 1, a construction far superior to that of Fig. 4, have shown compressive stresses at the end of the shell so high as to exceed the yield point of the metal.

Departure From Round Complicates Stresses

The foregoing computation of the compressive stress assumed the end of the shell a perfect circle. As a matter of fact perfectly circular shells are like perfection in other things—something to strive for. A deviation of 2 in. from the average diameter of a 48-in. shell is scarcely noticeable, yet the transverse stress resulting from bringing the shell to a true circle is about 8,000 lb. per square inch, which is added, with proper sign, to the direct tensile stress produced by the pressure. This lack of truth, with its consequent high stress, coupled with the bending stress produced by the effort of the cover and a portion of the shell to assume a sphere, makes the construction shown in Fig. 4 entirely inadequate for high pressures. A number of failures of tanks with heads of this description have come to my attention. One, carrying gasoline at a working pressure of 30 lb. per square inch, caused the loss of six lives and the destruction of many thousands of dollars worth of property.

Because of the high compression at the end of the shell it would seem best to insert the flange of the head into the shell as in Fig. 1 and have the benefit of the two thicknesses of metal to withstand the tendency to collapse. While the butt joint shown in Fig. 6 is neat in appearance, it is more difficult to apply and, of course,

does not provide the rigidity of the construction shown in Fig. 1.

A means of resisting the compression at the end of the shell is shown at one side of Fig. 4. An angle is welded to the shell with the outstanding leg forming a flange, which arrangement gives a large value of the section modulus and an increased resistance to the transverse stress produced by the departure of the shell from a true circle. Assume as before that 3 in. of the end of the shell is effective in resisting the compressive force of 85,400 lb. With an allowable stress of 11,000 lb. per square inch in the steel, the required sectional area of the channel shape formed by the 3 in. of the end of the shell and the angle is $85,400/2 \times 11,000 = 3.88$ sq.in. The end of the shell provides $3 \times 0.3125 = 0.9375$ sq.in., and the remainder, $3.88 - 0.9375 = 2.9425$ sq.in. is provided by a 4 in. $\times$ 3 in. $\times$ $\frac{7}{16}$ in. angle. (Had we taken advantage of the "Poisson-ratio effect," a 3 in. $\times$ $2\frac{1}{2}$ in. $\times$ $\frac{5}{16}$ in. angle would do.) The comparatively low stress of 11,000 lb. per square inch, less than one-third the elastic-limit of the steel, is ample protection from the result of whatever deviation there might be from a true circle, because the angle can, and should be, rolled to very nearly a true circle. The angle-ring should be welded to the shell before applying the head, which will insure the shell being truly circular.

Elliptical Head Gaining in Acceptance

A new head is coming into use which is known as the "elliptical" head. A section through the center of this head is a semi-ellipse whose minor axis is one-half the major axis. It is shown in Fig. 6. It is specified that the thickness be not less than the thickness of a seamless shell of the same diameter. The design formula for the same grade of steel and factor of safety as in the foregoing formulas is $t = 5\ PD/2T$, in which D is the diameter of the shell, or the length of the major axis of the ellipse. Heads with manholes should have the thickness of a head dished to a segment of a sphere with a dish radius equal to 0.8 times the diameter of the shell, and with the addition of 15 per cent, or not less than $\frac{1}{8}$ in., for the manhole; that is, according to the formula $t = (8.33 \times 0.8DP/2T) + 15$ per cent or $\frac{1}{8}$ in., which makes the manhole head approximately 50 per cent thicker than the blank head. In Fig. 2 is a graph showing the thickness of blank elliptical heads for various diameters and pressures, and in Fig. 3 a graph for manhole heads.

The formula for the blank head produces a head of twice the required thickness of a sphere of the diameter of the shell, which is intended to care for the bending moment caused by its departure from a true sphere. Strain measurements of this head have shown stresses approximating those in the shell.

All of the heads described in the foregoing deflect considerably due to the effort to assume a truly spherical form. A refiner, wishing to satisfy a curiosity about the amount of this deflection and thinking that some means of multiplying the deflection was necessary, rigged up a long lever which would magnify the deflection at the crown of the head. When pressure was applied to the tank, the end of the lever moved upward so quickly and so far that the experimenters were startled.

The heads described in the foregoing, with a bolting flange at the periphery as shown in Figs. 7 and 8, are often applied to tubular heat exchangers. In the multipass type the change of direction of flow in the tubes is effected by means of baffles welded to the heads. In some exchangers, because of the close spacing of the tubes, the baffles are necessarily thin, and consequently have little effect as beams in resisting the bulging of the head. The result is that the head bulges, the baffles buckle and, lifting from their seats on the tube sheet, permits the fluid to bypass. Naturally, a heat exchanger cannot yield its maximum capacity when a considerable quantity of the fluid avoids the passage through the tubes; and tests of the heat conductivity of this kind of apparatus must certainly be misleading for the same reason. Measuring the head-to-head dimensions of these exchangers before and after the application of pressure will reveal the extent of gap between the baffle and tube sheet.

Another objection to the use of this type of head on heat exchangers is a large hydraulic loss. Because of the great depth of the head, the fluid passage is many times the area of the tubes leading into it, consequently the sudden enlargement to the flow, followed by a sudden contraction as it enters the tubes of the next pass, causes a loss of velocity-pressure that is multiplied by the number of passes.

Fig. 9 — Stayed heat-exchanger head which avoids bypassing due to bulging under pressure

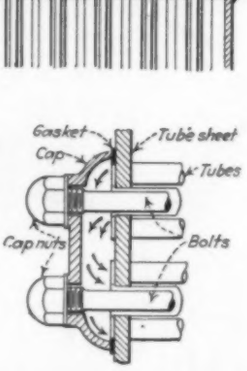


Fig. 10 — Cap for group of heat exchanger tubes, a development of the head of Fig. 9

In order to avoid the effects of bulging of the dished head, the head shown in Fig. 9 was developed. In this case the tubes are arranged in groups—one large central tube surrounded by a number of smaller ones. The bolt or rod which restrains the head passes through the central tube to the opposite head with cap nuts bearing on the outside as shown. The rod, passing through the central tube, produces an annular space for the flow of the fluid that is conducive to efficient heat transfer. The depth of the head is made to suit the maximum flow of fluid and the curved baffles direct the flow into the next pass with a minimum loss of pressure. The baffles are capable of adjustment to the desired number of tubes per pass by means of dowels in the head. By dividing the head into sections with individual pipe connections part of the exchanger may be cleaned while the rest is in operation. A development of this idea is the cap shown in Fig. 10 which may serve any number of tubes; or with the appropriate pipe connections may adapt the exchanger to the heating or cooling of a number of different fluids passing through the tubes.

Weighted Per Cent Equation Aids Chemical Calculations

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CONVERTING the percentage of either component in a binary mixture, expressed on a weight, volume or molal basis, to another of these three bases, is a frequent need in chemical engineering calculations. The conversion is not a difficult one, but it is unnecessarily time consuming if it is to be carried out with any frequency. Two charts have been developed to expedite the conversion. One of them, Fig. 1, is satisfactory for most engineering use as its accuracy is usually equal to that of the data. Where greater accuracy is required or for checking purposes, Fig. 2 is provided.

These charts solve the weighted-per-cent equation which gives the relation between the percentage composition of a binary mixture according to one basis of measurement and according to another, where the second composition percentages are weighted with respect to the first. In addition to uses for statistical purposes, this equation is frequently applicable in chemical work.

When percentages are given as whole numbers (*i.e.*, 76 per cent, *not* 0.76) the equation is:

$$P' = \frac{100}{1 + \frac{W_H}{W_L}\left(\frac{100 - P}{P}\right)} \quad \text{or} \quad \frac{100}{1 + R\left(\frac{100 - P}{P}\right)}$$

where P = per cent of the light component on the original basis (*i.e.*, unweighted per cent); P' = per cent of the light component on the final basis (*i.e.*, weighted per cent); W_L = weighting of the light component (*i.e.*, molecular weight, density, etc.); W_H = weighting of the heavy component (also molecular weight, density, etc.); and R = the weighting ratio = W_H/W_L. The derivation of the equation is as follows:

$$P' = \frac{100\,W_L P}{W_L P + W_H\,(100 - P)} = \frac{100}{1 + \frac{W_H}{W_L}\left(\frac{100 - P}{P}\right)}$$

A number of applications of this equation are given in the accompanying table. Their solution is much simplified through use of the charts of Figs. 1 and 2 which permit reading, directly in the case of Fig. 1 and indirectly in the case of Fig. 2, any one of the three quantities: weighted per cent, unweighted per cent, or weighting ratio (P', P or R) if the other two are known. For example, refer to Fig. 1. Let P = 24.5 per cent and

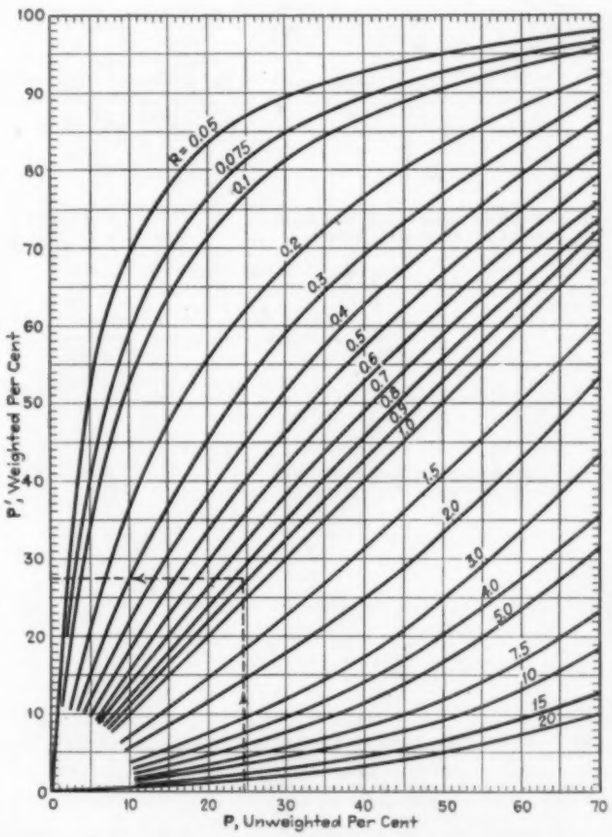

Fig. 1—Chart for solving weighted-per-cent equation as applied to most engineering calculations

R = 0.85. Reading up from 24.5 per cent on the unweighted per cent scale to the intersection with R = 0.85, we find weighted per cent on the vertical scale to be 27.6. Or, this can be determined from the equation:

$$P' = \frac{100}{1 + 0.85\left(\frac{75.5}{24.5}\right)} = \frac{100}{1 + 2.62} = 27.6 \text{ per cent}$$

The chart of Fig. 2, as was noted above, is used for checking or where Fig. 1 is not sufficiently accurate. It serves as a check because it arrives at the result by a totally different method, and is more accurate because it

can be interpolated accurately. Instead of giving the weighted per cent directly, it gives an increment percentage, I, of the unweighted per cent, P, which must be added to P to give the weighted per cent, P'. That is, the percentage found from the chart, multiplied into the unweighted per cent, gives an increment which, added to the unweighted per cent, gives the weighted per cent. The chart solves the equation $I = (P' - P)/P$ where P' is as defined above. For example, using the same problem as above, enter the chart at 24.5 per cent on the left-hand scale, going horizontally to intersect the line for $R = 0.85$. From this point go vertically to Curve A and from the latter intersection back horizontally to the left-hand scale, emerging at 12.8 per cent, which is the percentage of the original unweighted per cent to be added to it to give the weighted per cent. Thus, 24.5

Examples of Use of Weighted Per Cent Equation

Application | **Equation** | **Nomenclature and Substitution of Values**

I — Finding molal per cent from weight per cent (and reverse)

$$P_M = \frac{100}{1 + R\left(\frac{100 - P_W}{P_W}\right)}$$

P_M = Molal per cent ofl ower molecular weight fraction
P_W = Weight per cent of lower molecular weight fraction
M_L = Molecular weight of lower molecular weight fraction
M_H = Molecular weight of higher molecular weight fraction
R = Weighting Ratio = M_L/M_H

Example:

Component	Weight Per Cent	Molecular Weight
A	20	18
B	80	32

Molal per cent A = $P_M = \dfrac{100}{1 + \frac{18}{32}\left(\frac{80}{20}\right)} = 30.8$

II — Finding volume per cent from weight per cent (and reverse)

$$P_V = \frac{100}{1 + R\left(\frac{100 - P_W}{P_W}\right)}$$

P_V = Volume per cent of lighter fraction
P_W = Weight per cent of lighter fraction
D_L = Density (or specific gravity) of lighter fraction
D_H = Density (or specific gravity) of heavier fraction
R = Weighting Ratio = D_L/D_H

Example:

Component	Weight Per Cent	Density
A	70	50
B	30	60

Vol. per cent A = $P_V = \dfrac{100}{1 + \frac{50}{60}\left(\frac{30}{70}\right)} = 73.7$

III — Finding molal per cent from volume per cent (and reverse)

$$P_M = \frac{100}{1 + R\left(\frac{100 - P_V}{P_V}\right)}$$

Note: In this case the subscript letters L and H refer to the fraction having the *lower or higher ratio* of molecular weight to density. M/D.

P_M = Molal per cent of lower ratio fraction (see above)
P_V = Volume per cent of lower ratio fraction
M_L = Molecular weight of lower ratio fraction
M_H = Molecular weight of higher ratio fraction
D_L = Density (specific gravity) of lower ratio fraction
D_H = Density (specific gravity) of higher ratio fraction
R = Weighting ratio = $\dfrac{M_L\ D_H}{D_L\ M_H}$

Example:

Component	Volume Per Cent	Molecular Weight	Density	M/D
A	60	32	60	0.53
B	40	46	50	0.92

Molal per cent A = $P_M = \dfrac{100}{1 + \frac{32\times50}{60\times46}\left(\frac{40}{60}\right)} = 72$

IV — Finding per cent on basis of constituent present in two components in different proportions (such as on solid basis in mixture of two solutions of different concentrations) from weight per cent or volume per cent (and reverse)

$$P_c = \frac{100}{1 + R_1\left(\frac{100 - P_W}{P_W}\right)}$$

$$P_c = \frac{100}{1 + R_1\left(\frac{100 - P_V}{P_V}\right)}$$

P_W = Per cent on weight basis of component showing higher proportion of constituent on basis of which comparisons are being made
P_V = Per cent on volume basis of component showing higher proportion of constituent on basis of which comparisons are being made
P_C = Per cent of total of this constituent in mixture which is supplied by high component
D_H = Density of high component
D_L = Density of low component
W_H = Per cent of constituent in high component, on weight basis
W_L = Per cent of constituent in low component, on weight basis

Note: W_H is greater than W_L, and P_W and P_C correspond to same component as W_H. Also, when working from volume per cents $W_H\ D_H$ must also be greater than $W_L\ D_L$ or subscripts must be interchanged.

Weighting ratio: $R_1 = \dfrac{W_L}{W_H}$ and $R_1 = \dfrac{W_L\ D_L}{W_H\ D_H}$

Example 1:

Component	Weight Per Cent in Mixture	Per Cent N_1 in Component
A	70	30
B	30	18

Per cent of total N_1 supplied by A = $P_C = \dfrac{100}{1 + \frac{18}{30}\left(\frac{30}{70}\right)} = 79.5$

Example 2:

Component	Vol. Per Cent in Mixture	Per Cent N_1 in Component	Density	$W\times L$
A	60	30	50	1.500
B	40	18	60	1 080

Per cent of total N_1 supplied by A = $P_C = \dfrac{100}{1 + \frac{18\times60}{30\times50}\left(\frac{40}{60}\right)} = 67.5$

Note: These two formulas can also be used in systems of more than two components, provided only two components have a content of the constituent being used as a basis of comparison, and the per cents by weight of these two components of the mixture, before any others are added, are used in the formula rather than the per cents by weight on the total mixture. (For example, in the above case the formula can still be applied with the provisions given, even though another solvent which is without a solid content be added to the mixture).

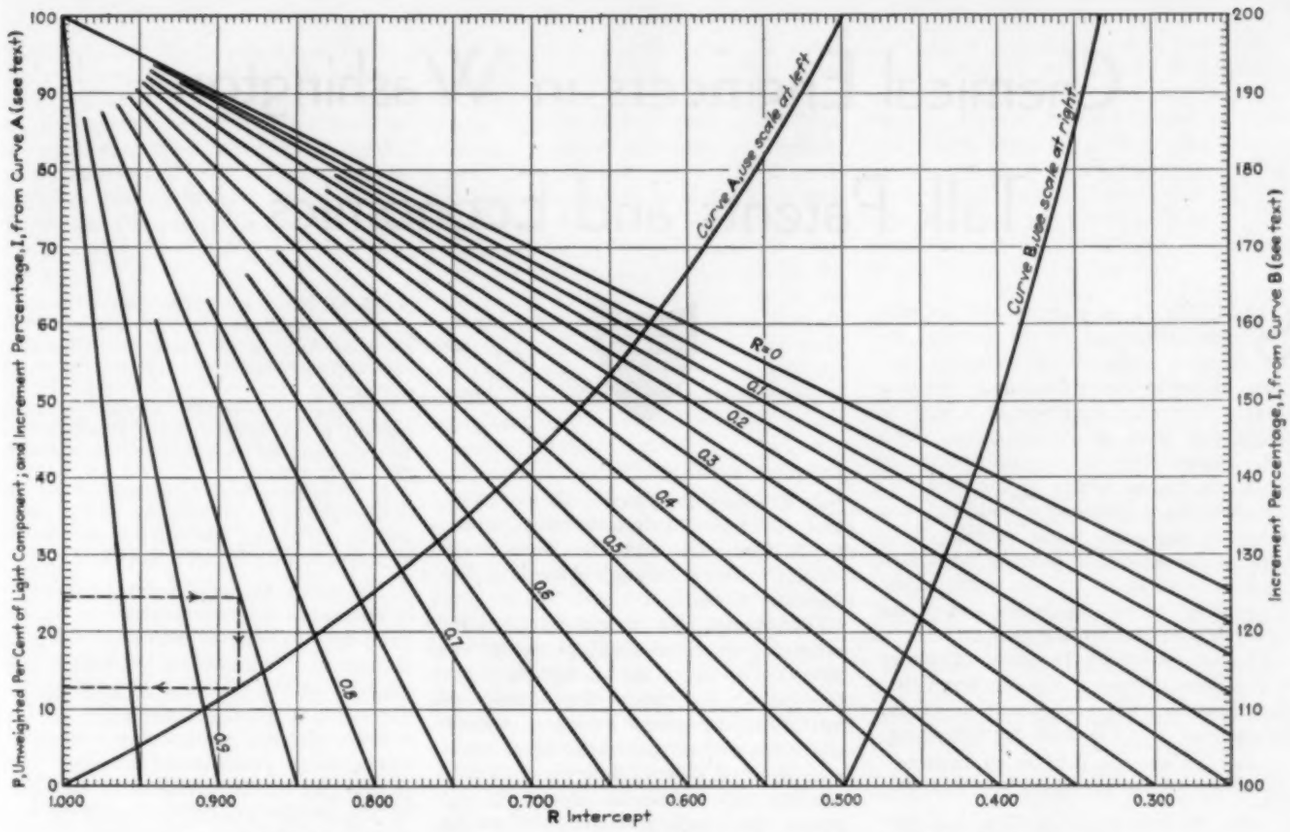

Fig. 2—Weighted-per-cent-equation chart for checking or for problems involving high accuracy

$+ 24.5 \times 12.8 = 27.6$. Curve B, which is an extension of Curve A and is used with the right-hand scale, is to be used where the intersection of the original horizontal with the R line in beyond the scope of the A Curve. It is to be noted that the R lines intersect the axis of abscissas and that the intersections are proportional to $(1 - R)$. Hence, interpolation can easily be accomplished by drawing an interpolated R line from the origin of R lines in the upper left-hand corner to the corresponding value of the R intercept.

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Gallium Now Commercially Available

ALTHOUGH it has been known since 1875, it is only within the last two years that gallium has been isolated in commercial quantities. Improved production methods developed by the Vereinigte Chemische Fabriken zu Leopoldshall, Germany, have made possible a price in the United States of $3.60 per gram as compared with over $200 per gram only a few years ago. It is understood that American representation for this company has recently been arranged.

Gallium is a silvery metal which melts at body temperature and has an extremely high boiling point of about 2,000 deg. C. It occurs to the extent of about 0.001 per cent in zinc blend and other earths. It is not tarnished nor corroded by exposure to air.

A considerable number of applications for gallium have already been put to use. These fall principally into the fields of thermometry, dentistry, atomic and astrophysics and, particularly, radio and electro technology. Because of the metal's high melting point, gallium thermometers can be made for temperatures of 500 to 1,000 deg. C., much higher than mercury thermometers. In distinction to mercury, gallium is non-poisonous and is, therefore, to be preferred as an ingredient in tooth fillings. One German university clinic has for some time successfully utilized fillings containing gallium.

Gallium is also being used for optical mirrors, since it appears that the light absorption losses are thereby reduced. The atomic and astrophysical researches made heretofore in spectrum analysis, which were hindered by insufficiencies of the mercury quartz lamps, can now be clarified by the use of gallium lamps. On account of the favorable electrical qualities of the metal attempts are being made to use it in lighting tubes and photo-electric cells. Furthermore, it would appear that gallium may be of value in infra-red transmission. In a recent French discovery, gallium is used as a cathode material for electron tubes. Filaments of gallium or its alloys emit electrons at lower temperatures than ordinary filaments and require much less current for heating. Attempts are being made to substitute gallium for mercury in rectifiers since the metal's high boiling point will permit operation at much higher capacity. It is expected that gallium will also find application for fire alarms, signals and similar applications.

Chemical Engineers in Washington Talk Patents and Economics

SYMPOSIA on patents and on economic problems of the process industries featured the technical program of the twenty-fifth annual meeting of the American Institute of Chemical Engineers held in Washington, Dec. 7-9. Assembling in the auditorium of the U. S. Patent Office in the new Department of Commerce Building, the chemical engineers were privileged to hear a discussion of patents presented from the viewpoints of the corporation, of pending federal legislation and of the ownership of intellectual property.

Thomas Griswold, Jr., patent attorney of the Dow Chemical Co., declared that the objectives of a corporation patent department should include the following:

(a) To provide that patent matters shall be handled by specialists in that line;

(b) To coordinate the activities of other departments, respecting the requirements of patent and trademark laws;

(c) To organize invention, research and patent data for instant availability;

(d) To centralize patent control for efficiency and effectiveness;

(e) To obtain and protect patent monopoly;

(f) To keep the business out of patent troubles.

Citing the case of his own company, whose patent work prior to June, 1927 was handled chiefly by an out-of-town firm of patent attorneys, Mr. Griswold was able to show how a house patent department was organized and operated with a minimum of expense to obtain the following desirable results: Closer cooperation between inventors and attorneys, better teamwork in preparing and prosecuting applications, more complete and promptly accessible records and data, and, finally, a more extensive service to the business as a whole, due to the smoother functioning of the research and other departments in matters of searches, art citations, reports on patentability, and infringement.

The Patents Committee of the Institute, under the chairmanship of R. S. McBride, reported on its work, which included an extended review of the proposed legislation considered by the House of Representatives committee during the last session of Congress. The Institute Committee secured the approval of Council to take official stand favoring one of these bills which proposed the founding in the Patent Office of a classification division. With respect to other proposed bills on which some difference of opinion exists within the Institute, it was the decision of Council to work through American Engineering Council.

The round-table discussion on the ownership of intellectual property was organized to show the viewpoint of the quasi-public institution, the educational institution, the patent status of federal employees and certain other legal interests. E. R. Weidlein, director of Mellon Institute of Industrial Research, explained that each industrial fellowship in the Institute is the subject of a definite agreement between its donor and the institution, whereby all results obtained are the property of its donor, who decides as to whether this intellectual property shall be presented to the patent office for legal protection. Applications are made by the inventor and if allowed, the invention is assigned to the donor. There is no exception to the fundamental principle that title to patent rights accrue to the employer of the research man who is specifically hired for the purpose of getting new knowledge of practical value to the donor. Mr. Weidlein said that this procedure has worked out satisfactorily in twenty-five years of experience in the application of science in the industry.

Prof. James R. Withrow of the Ohio State University, in discussing the patent problems of educational institutions, reviewed the more or less definite plans now in operation at Wisconsin, Toronto, Massachusetts Institute of Technology, Michigan, Columbia, Ohio State and Cornell universities. As an example of a fair policy, he cited that of M.I.T. which contains the following rules:

1. Inventions and developments resulting directly from research financed by the institution shall be its exclusive property and the rights are administered for the ultimate benefit of the public.

2. Inventions produced by a staff member or student along lines unrelated to the Institute program with which the individual may be connected, shall be the exclusive property of the individual.

3. Occasions where the development is produced by a student paying tuition, it shall be considered that the Institute does not contribute to the research. The same rule applies when the student is receiving scholarship aid.

4. Where a contract is made with an outside party with definite provision for all expenses, the Institute has no claim to the rights.

5. In intermediate cases where the expenses are borne jointly by the Institute and an individual, the equities are divided in proportion to the contribution.

The patent status of federal employees is somewhat more complicated. L. W. Wallace, executive secretary of the American Engineering Council, declared that the inventor in general employment is usually considered to have a more definite patent status than his colleague in government employ. The complexity of the problem is increased by the steady growth in research conducted jointly in government laboratories by federal employees and research associates supported by industry. Mr. Wallace's paper presented in brief the statute law underlying the whole situation, indicating an outline of decisions and cases which have become precedents for future decisions. The cases cited seem to establish the fact that the government has a non-exclusive license in every patent taken out by a person while in the employ of the government. Whenever there is a specific assignment to a particular problem either at the start of the employment or later, the title to any patent that may arise belongs to the government. Where there is no specific assignment, the title may belong to the employee.

The history and experience of the Research Corp. in the public administration of patent rights was briefly discussed by Dr. F. G. Cottrell. Referring to this experience as a frank experiment is an untrodden field, Dr. Cottrell showed that many new problems are involved which cannot be anticipated in every instance. For example, the Research Corp. was forced into the actual manufacture of equipment for electrostatic precipitation despite the fact that its original plan was to serve solely as a licensing agent. Although the Research Corp. is continuously searching for new processes and products that might be administered on a comparable basis, to date its principal source of revenue has been the original Cottrell patent.

The round-table discussion was concluded with a paper by Karl Fenning,

patent attorney of Washington, D. C., who reviewed the legal aspects of certain problems in the ownership of intellectual properties. He confined most of his attention to the relation of employers and employees and cited numerous cases in which the courts have attempted to clarify that situation. In general these relations may be divided into the following:

1. Inventions having no bearing upon the employee's duties and made outside of office hours are the property of the employee, and the employer has no interest in them. Solomans v. U. S. 137 U. S. 342.

2. Inventions arising out of or made in connection with the employee's duties and incidental thereto by an employee whose duties do not include the conducting of research or inventive work. Here the employee retains the title to the patent, but the employer is entitled to a shop right or a non-exclusive license. Gill v. U. S. 160 U. S. 426.

3. Inventions made by an employee in connection with and within the field of his work, where his duties include the conducting of research and inventive work.

(a) Where the employee was specifically assigned to the task of making the invention, the entire property right to the invention vests in the employer. Standard Parts Co. v. Peck 264 U. S. 52.

(b) Where the invention is within the general field of employee's research and inventive work, but where he was not specifically assigned to develop the particular invention, the courts generally have held that the patent and invention do not belong to the inventor.

The only safe conclusion, according to Mr. Fenning, is to have a definite written agreement with all employees covering all inventions relating to the specifically defined field in which the employer is operating or interested, and whether made during the term of employment or afterwards.

The symposium on economic problems of the process industries was opened by Dr. Henry G. Knight, chief of the Bureau of Chemistry and Soils, who said that one important phase of the farm problem seems to resolve itself into the development of commercially feasible non-food uses for the vast amount of culls, surplus and wastes from our food crops.

Economic pressure has forced many of our technical executives to a realization that cost accounting is one of their most valuable tools not only in reflecting and explaining past events, but also in gaging their own performance and that of their subordinates. A. G. Peterkin and H. W. Jones, chemical engineers for the Atlantic Refining Co., reported that an important change is taking place in the direction of cost accounting in many industries. Systematic methods of analysis have been devised which automatically indicate underlying causes of economic variations and increase the probability of prompt and beneficial executive action. This change has made it necessary for the chemical engineer to know to a certainty the method and basis on which his cost figures are derived. He must guard against errors that arise from arbitrary routine proration of indirect costs. The effect of any change in manufacturing procedure or in business conditions is most safely determined by consideration of the response of each item of direct or indirect costs in the total. The most frequent cause of inaccuracy in cost figures according to these authors is the failure of the technical designer or operator to provide adequate means for the measurement of the quantities of materials used in his process.

The chaotic condition of our railroads today can be largely ascribed to the effect of too much theory and too little practicality according to a paper by Harry M. Mabey, general traffic manager of the Mathieson Alkali Works.

Stability in the freight rate structure is of paramount importance to all industrial activities. While loss of revenue distressed the railroad, lack of stability in rates now disturbs industry and makes forward commitments uncertain. Therefore, industry and the railroad have a common interest in securing legislation that will so regulate the accessorial services such as motor vehicles and waterways that their costs may be fairly fixed and their charges stabilized. After such regulation, he contended, if practical economics could prevail, the railroads should seek the right and should be enabled to enter into any form of transportation service by rail, pipe line, on the highway or in the air, which public convenience is found to warrant, under proper regulation. He added: "If anything has been well demonstrated in recent years, it is that no one benefits from rate wars and chaos resulting therefrom, nor from needless duplication of transportation facilities."

Frank L. Hess of the U. S. Bureau of Mines concluded the economic symposium with a discussion of mineral raw materials of special interest to the process industries.

Two papers presented on Dec. 7 by T. K. Sherwood and E. W. Comings, of the Department of Chemical Engineering at M.I.T., dealt with important aspects of drying. The first, an experimental study of the wet-bulb hygrometer, brought out the fact that the use of the standard humidity charts, for wet and dry bulb thermometry is basically unsound. These charts are in common use by all engineers who use the "adiabatic cooling lines" to interpret wet and dry bulb thermometer readings. For water vapor and air, this method fortunately gives results which are usually within the accuracy of engineering calculation. The authors point out, however, that this use is justified in engineering calculations only for water vapors in air and then only at moderate and high humidity. The second paper on the drying of clays is the fifth in the series from Professor Sherwood's laboratory on the mechanism of drying various solids, the importance of the type of data presented indicating the optimum drying conditions at various stages in the drying process.

Dr. F. W. Adams of M.I.T. discussed the absorption of sulphur dioxide in water, having studied the relation in a spiral-tile packed tower of the effect of liquor velocity, gas velocity and temperature on the mechanism of absorption. Data suitable for the design of absorption equipment have been obtained in the practical operating ranges of these variables. The overall resistance to the absorption of sulphur dioxide comprises both gas and liquid film resistances, although the latter is generally of major importance. Resistance to its absorption may be reduced by increasing liquor velocity, temperature and gas velocity, the magnitude of the effect being in the order named. Overall resistance (R_L) is inversely proportional to the 0.89 power of the liquor velocity. The effect of temperature on overall resistance at low gas and liquor velocities is similar to its effect in a wetted-wall tower; at high liquor velocity, the effect is much greater. Gas velocity affects the resistance to absorption at higher liquor velocity, but is important at low liquor velocity.

Another contribution was that of Prof. Warren L. McCabe of the University of Michigan who discussed the use of "availability" in process steam cost accounting practice. This term, first used by Keenan before the A.S.M.E. in New York in 1930, takes into account the differences in the thermodynamic value of steam at different temperatures and pressures. While the Keenan method considered the boiler, prime mover and their auxiliaries separately, McCabe combined them as a unit and developed a modified cost accounting method by introducing the concept of "equivalent power." He derived a new equation based on these factors and in a number of practical examples, calculated the cost of power per kilowatt-hour and the price of steam per 1,000 lb. with credit for condensate in plants where both power and process steam are developed.

A well attended technical feature of the meeting was a large-scale demonstration of dust explosion hazards carried out at Arlington, Va., under the direction of Dr. David J. Price, principal engineer in charge of the chemical engineering division, Bureau of Chemistry and Soils. Hylton R. Brown, engineer, and R. L. Hanson, assistant engineer conducted the demonstrations.

BOOKSHELF

Light on Organic Reactions

THE FREE ENERGIES OF SOME ORGANIC COMPOUNDS. Published by The Chemical Catalog Co. 347 pages. Price, $4.50.

Reviewed by *D. B. Keyes*

ORGANIC chemical industries in this country have only recently appreciated the value of free energy determinations. The $\Delta F°$ value for an organic chemical reaction indicates accurately, under the specific conditions, the extent to which the particular reaction will go. It says nothing, however, regarding the catalyst or the rate of reaction.

This book is a most excellent review of the entire subject. The authors not only give the outstanding data, but they explain in detail the method used in each determination and they critically review the results. From time to time throughout the book and in the Appendix, special methods that will facilitate work of this kind are described. This makes the book not only of interest to the research worker who uses free energy values, but also to the scientist who must determine the values.

Free energy values for organic reactions are more difficult, on the whole, to determine than are the same values for inorganic reactions. This is largely due to the character of organic chemical equilibria and also to the fact that usually the side reactions in organic chemical work are considerably more numerous than they are in the inorganic field. Analytical methods have not been developed in organic chemistry to the extent that the- have in inorganic chemistry. It is therefore no wonder that this general subject has received less attention by scientific investigators. On the other hand, it should be remembered that from the industrial standpoint free energy values of organic reactions are equally important.

It is hoped that this book will stimulate a real interest among our industrial laboratories in the general subject and increase the number of known free energy values for organic reactions. This factor alone would be sufficient to justify this excellent treatise.

Why Engineering?

ENGINEERING: A CAREER—A CULTURE. Published by the Education Research Committee of the Engineering Foundation, New York. 61 pages. Price, 15 cents.

ADDRESSED TO young men and to parents and teachers, this pamphlet presents a clear picture of the broad field of opportunity in the engineering profession. The functions of the engineer are stated with the precision which springs from intimate knowledge of both theory and practice. Each of the major divisions of engineering—civil, mechanical, mining and metallurgical, electrical and chemical—is comprehensively described from the professional standpoint. Nor does this pamphlet neglect the cultural aspects which have been too long obscured. Contrary to common opinion, engineering education possesses cultural values comparable to those which inhere in the fine arts. The significance of this is made clear in order to aid the young man in deciding whether through this profession he can realize his ideals and ambitions.

The members of the Education Research Committee and the societies cooperating in the preparation of the pamphlet are: Harvey N. Davis, American Society of Mechanical Engineers, chairman; Walter F. Whittemore, American Society of Civil Engineers; Thomas T. Read, succeeding William B. Plank, (Charles H. Fulton, alternate), American Institute of Mining and Metallurgical Engineers; Walter S. Rodman, American Institute of Electrical Engineers; R. I. Rees, (H. P. Hammond, alternate), and Joseph W. Barker, Society for Promotion of Engineering Education; Alfred H. White, American Institute of Chemical Engineers; Alexander R. Stevenson, Jr., The Engineering Foundation. James T. Grady, of Columbia University, is literary adviser, and D. H. Killeffer, editor.

Twenty-five Years of Chemical Engineering

SILVER ANNIVERSARY OF CHEMICAL ENGINEERING IN AMERICA. Published by D. Van Nostrand & Co., New York, for the American Institute of Chemical Engineers, Bellevue Court Bldg., Philadelphia, Pa. 76 pages. Price, 50 cents.

AS AN appropriate souvenir of its twenty-fifth annual meeting held in Washington, D. C., earlier this month, the American Institute of Chemical Engineers has issued an illustrated pamphlet reviewing the progress of the profession in the United States during the past quarter of a century. Prof. John C. Olsen has contributed an interesting account of the personalities and events that lead to the founding of the organization in Philadelphia on June 22, 1908. The work of important Institute committees on ethics, membership, publication and education is reviewed by G. W. Thompson, M. H. Ittner, F. C. Zeisberg, and H. C. Parmelee—all of whom have been prominently identified with these special activities. Frederic J. LeMaistre, executive secretary, brings the Institute's story up to date in a brief discussion of its present status and prospects.

A well-rounded chapter by Prof. Alfred H. White reflects the development of chemical engineering education in this country and indicates the pedagogical basis on which rests the future of the profession. "Chemical Engineering Research—Lifeblood of American Industry" is the title of the contribution of Dr. Arthur D. Little, whose chapter is followed by typical records of research in twenty or more American companies.

This souvenir pamphlet is the forerunner of a special Silver Anniversary Volume of the Institute's Transactions which will be published prior to the June, 1933, meeting in Chicago. The latter volume will review in detail the chemical engineering progress of the process industries and some of the principal unit operations. These chapters are being prepared under the editorship of Sidney D. Kirkpatrick by a group of qualified chemical engineers and executives representative of the membership of the organization.

Chemical Engineering In Germany

ELEMENTE DER CHEMIE-INGENIEUR-TECHNIK. By *Walter L. Badger* and *Warren L. McCabe* and translated into German by Dipl. Ing. K. Kutzner. Verlag von Julius Springer, Berlin, Germany. 489 pages.

IN THE TRANSLATOR'S preface to the German edition of this popular American text, it is stated that the pedagogical side of chemical engineering has advanced farther in the United States than in Germany, despite the fact that the latter pioneered the field of chemical engineering education. Only one major alteration has been made in the translation. Mr. Kutzner states he has omitted the series of problems at the end of each chapter because he is convinced "that the book will never be used as a textbook, and the German reader will not be able to find the time necessary for the solution of such problems, either during his course or immediately thereafter." This comment would seem to indicate that the average chemical engineer in Germany is still expected to possess only a descriptive knowledge of equipment without the quantitative concept that underlies its design and operation. The next review indicates, however, that a trend in this direction is already underway.

DER CHEMIE-INGENIEUR. Vol. II. By *A. Eucken and M. Jakob.* Akademische Verlagsgesellschaft m.b.H., Leipzig, Germany. Part I. 208 pages. Price, 18.60 M. Part II. 274 pages. Price, 27.60 M.

ALTHOUGH A thorough knowledge of fundamental reactions still remains the primary requisite for the chemical engineer, modern technology is making increasing demands for a quantitative understanding of the physical principles upon which successful industrial application of the processes is based. In Germany this concept has not been as popular as it has been in the United States. However, this book appears to be a start in that direction and should do much to supplement that side of the chemical engineer's education.

Part I of Vol. II, describes equipment used in plant control. Part II, for which Professor Fritz Haber has written an interesting foreword, deals further with units of measurement and the practical means for their application in industry.

Other's Views on "Modern Metals"

To the Editor of Chem. & Met.:

Sir:—Your publication is to be congratulated on the comprehensive compilation of data on metals and alloys published in your September number. You emphasize in your foreword and it is well known to virtually all manufacturers offering metals which are resistant to corrosion, that the listing of such materials in a general way as resistants to various reagents should be employed by the reader as indices rather than appropriated by him as the ultimate word in resistance of a product to a given reagent.

Commercial applications entail so many variations in conditions, which on the surface seem identical but which contain subtle and important differences that the *unguided* use of such data sheets may be disastrous both for the process operator and for the metal manufacturer. Such consequences cannot help but materially hurt this industry which is still of infantile proportions.

Therefore, we believe that sufficient importance and emphasis was not placed on footnote 11, which appears on page 512 of the data sheets, and which reads as follows: *"Before recommending an alloy for corrosion service, company prefers to know all details of service conditions."*

We wish to state most emphatically that blanket recommendations for corrosion resistance of metals to given reagents may be misleading, particularly under conditions of commercial application and in which the reagents are contaminated by virtue of the process or production with such other reagents as to influence materially the satisfactory resistance of a given metal to a given chemical. We are therefore providing you with a sheet* showing the resistance of cast alloys manufactured by us to the reagents listed in your "Modern Metals" section, but with the understanding that these resistivities are to be considered only as indices.

We also suggest that *Chem. & Met.* call attention in your correspondence columns to the fundamental considerations included above, and particularly, to give appropriate emphasis to the important footnote previously cited. This procedure should be beneficial to the industry at large.

G. C. MCCORMICK,
Vice-President.
General Alloys Company,
Boston, Mass.

*Editor's Note: Copies available on request to the editorial offices of *Chem. & Met.*

Non-Shatterable Glass

We are informed by the American representative of the European companies making Sekurit glass (*Chem. & Met.*, Nov. 1932, p. 601) only flat glass has been developed commercially.

EDITOR.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

Comparison of Small and Large Scale Experimental Carbonizing Apparatus, by A. C. Fieldner and others. Bureau of Mines Technical Paper 543; 5 cents.

Clinker Formation as Related to the Fusibility of Coal Ash, by P. Nicholls and others. Bureau of Mines Bulletin 364; 10 cents.

Survey of the High-Sulphur Crude Oils (Black Oils) Produced in Wyoming, by H. M. Thorne and Walter Murphy. Bureau of Mines Technical Paper 538; 10 cents.

Analyses of Crude Oils From the Oklahoma City Field, Oklahoma, by E. L. Garton. Bureau of Mines Report of Investigations 3180; mimeographed.

Fatalities in the California Petroleum Industry During the Calendar Year 1931, by R. L. Marek. Bureau of Mines Report of Investigations 3182; mimeographed.

Toxicity of Dichlorotetrafluoroethane, by W. P. Yant and others. Bureau of Mines Report of Investigations 3185; mimeographed.

Protection Against Mercury Vapor Afforded by Canister Gas Masks, by W. P. Yant and C. E. Traubert. Bureau of Mines Report of Investigations 3187; mimeographed.

Radium in Medical Use in the United States, by R. R. Sayers. Bureau of Mines Information Circular 6667; mimeographed.

Starches. Bureau of Foreign and Domestic Commerce, Foodstuffs Division; mimeographed, 10 cents (copies should be purchased from Bureau). General information on starches, with statistics for domestic production, imports, and exports.

Motor Truck Freight Transportation. Bureau of Foreign and Domestic Commerce, Domestic Commerce Series No. 66; 10 cents.

International Trade in Machinery Belting, by E. G. Holt and R. H. Sanger. Bureau of Foreign and Domestic Commerce, Trade Promotion Series No. 135; 10 cents.

Shipping Samples and Catalogues. Bureau of Foreign and Domestic Commerce Trade Promotion Series No. 72 (revised); $1.00. Summarizes the methods for shipping samples and catalogs to foreign countries in order to comply with customs and trade regulations at the country of destination.

Foreign Commerce and Navigation of the United States, Calendar Year 1931. Bureau of Foreign and Domestic Commerce; $2.25. Gives import and export statistics for 1931.

Work of the Tariff Commission. U. S. Tariff Commission Miscellaneous Series pamphlet.

Silicon Aluminum, Aluminum Silicon, Alsimin, Ferro-Silicon, Aluminum, Ferro-Aluminum Silicon. Tariff Commission, Report No. 50, Second Series; 5 cents. Report to the President on the differences in costs of production in the U. S. and the principal competing country.

Inedible Gelatin, Glue, Glue Size, and Fish Glue. Tariff Commission, Report No. 52, Second Series; 5 cents. Report to the President on differences in costs of production in the U. S. and the principal competing country.

Index of Analyses of Natural Waters in the United States 1926 to 1931, by W. D. Collins and C. S. Howard. U. S. Geological Survey Water-Supply Paper 659-C; 5 cents.

Taxes on Lubricating Oil; Brewer's Wort and Malt Products; Grape Products; Matches; Soft-Drinks; and Gasoline Under the Revenue Act of 1932. Treasury Department, Bureau of Internal Revenue, Regulations 44.

Federal Specifications. New or revised specifications of the Federal Specifications Board on: Glycerin (Glycerol), 51Gld; Alcohol, 52A8a; Nickel, (for) Remelting, QQ-N-301; Tin, Phosphor, QQ-T-351; Aluminum, Ingot, 46A2a; Aluminum Alloy (Aluminum-Manganese), Sheet, 47A4b; Spiegeleisen, QQ-S-611; Ferromolybdenum, QQ-F-171; Turpentine, (for) Paint, LLL-T-791a; Iron, Wrought (Refined), Bars, QQ-I-686; Drums, Metal, Types 5A, 5C, and 5D (for Acids and Other Dangerous Articles), RR-D-701; Drums, Steel, Type 6A (for Phosphorus, White or Yellow), RR-D-736; Brick, Concrete, SS-B-663; Brick, Sand-Lime, SS-B-681; Slate, Roofing, SS-S-451; specifications are available from the Bureau of Supplies and Accounts, Navy Department.

Census of Dyeing and Cleaning 1931. Bureau of Census; mimeographed.

Mineral Resources of the United States 1931 (Summary), by M. B. Clark. Bureau of Mines unnumbered pamphlet; 10 cents.

Mineral Production Statistics for 1931—Separate pamphlets from Bureau of Mines on: Abrasive Materials, by Paul Hatmaker and A. E. Davis, 5 cents; Sulphur and Pyrites, by R. H. Ridgway, 5 cents; Fuel Briquets, by W. H. Young and others, 5 cents; Tungsten, by F. L. Hess, 5 cents; Gold and Silver, by J. P. Dunlop, 5 cents; Bauxite and Aluminum, by C. E. Julihn, 5 cents; Arsenic, Bismuth, Selenium and Tellurium, by C. N. Gerry and H. M. Meyer, 5 cents; Fuller's Earth, by Paul Hatmaker and Jefferson Middleton, 5 cents; Talc and Soapstone, by Oliver Bowles and B. H. Stoddard, 5 cents; Antimony, by Paul M. Tyler, 5 cents; Slate, by Oliver Bowles and A. T. Coons, 5 cents.

Production Statistics From 1931 Census of Manufactures in preliminary mimeographed form for: Acids; leather belting; electrical machinery, apparatus, and supplies (includes storage batteries, dry batteries, and carbon production); fertilizers; compressed and liquefied gases; manufactured ice; leather, tanned, curried, and finished; perfumes, cosmetics; and other toilet preparations; pig iron and ferroalloys; rubber goods other than tires, inner tubes, and boots and shoes; shortenings (other than lard), vegetable cooking oils, and salad oils; stamped and enameled ware; sodium compounds; wall plaster, wall board, insulating board, and floor composition; grease and tallow.

Mineral Production Statistics for 1931—preliminary mimeographed statements from Bureau of Mines on: Clay; fuel oil.

Power Show Exhibits Attract Numerous Spectators

AFTER its absence of two years, the National Exposition of Power and Mechanical Engineering returned for the tenth time to the Grand Central Palace in New York, during the week of December 5.

Perhaps the high point of the entire Show, in point of the comment it aroused, was a "near-perpetual-motion" machine which the Cochrane Corp., Pittsburgh, Pa., had put on exhibit. This intriguing but frankly impractical gadget is a vacuum vapor turbine and draws its energy from the atmosphere to generate an infinitesimal fraction of a horsepower. Its operating head is derived from the difference betwen the wet- and dry-bulb temperatures of the air surrounding the apparatus. A boiler, boiler drum, turbine shell and condenser, all formed of glass and all under high vacuum, constitute the equipment. The condenser is covered with a wick saturated with water which, evaporating, cools the condenser. The water is replenished continuously by capillarity. The boiler derives its heat from the atmosphere and the vapor jet issuing against a small turbine rotor causes it to whizz merrily.

Much of the equipment exhibited, of course, was not of direct interest to chemical engineers, and cannot enter this account. Other new equipment has already been described in earlier issues of *Chem. & Met.*, and so must be omitted here. Of the remainder, some of the more important pieces, from the chemical engineering standpoint, will be the subject of lengthier description in this or later issues.

New Control Instruments Numerous

Evidence was not lacking that the period of extensive robot control is with us. Of the total number of exhibitors with equipment of concern here, half were manufacturers of industrial instruments for the indication, recording and control of various operating variables. Bailey Meter Co., Cleveland, Ohio, demonstrated an improved and further refined form of its mercury-sealed, floating-bell flow meter. A novel mechanical integrator of ingenious design is used instead of the planimeter type previously employed in this company's meters.

The Bristol Co., Waterbury, Conn., showed a new differential-temperature controller, an adaptation of the recently developed free-vane principle which has already been the subject of extended description in *Chem. & Met.* Two temperature elements are coupled together so that only the difference of their indications serves to actuate the controlled system. This company has developed a new indicating controller of the free-vane type as well as a new humidity recorder.

Brown Instrument Co., Philadelphia, Pa., showed a sensitive smoke and fume recorder of novel design. The instrument consists of an air-cooled, double-walled tube with an opening which permits smoke to pass through, interrupting to a greater or lesser extent a beam of light passing from one end of the tube to a photo-cell at the other end. The photo-cell actuates a smoke-density recorder. A second development of this company has been given the name "Area-Type" flow meter. This instrument is installed directly in the fluid line, requiring no separate orifice. A sliding, piston-like gate connected to an electrical transmission of the type used in all of this company's electric flow meters tends to close the pipe and prevent flow. However, fluid forces the piston upward so as to open the passage and the amount of this displacement is proportional to the flow.

Continuous indication of the degree of opening of remote-controlled valves was shown by the Electric Indicator Corp., Stamford, Conn. This concern has also developed, for use in connection with the indicator, a remote control mechanism which permits opening or closing the valve to any desired degree. The indicating element employs as a transmitter a self-synchronous motor.

Foster Wheeler Corp., New York City, has evolved an interesting method of controlling the feed to ball and tube mills. Although it was developed for pulverized coal installations, the method is said to be applicable to other fine grinding. Air pressure is admitted to the discharge end of the mill through two small pipes. The upper pipe is open to the mill atmosphere. The lower pipe dips beneath the pulverized material level only when the level becomes too high. Thereupon the pressure unbalances a manometer and operates controls to stop the feeder motor until the level again drops.

Foxboro Co., Foxboro, Mass., showed a new six-point potentiometer pyrometer recorder. This is the first multi-point potentiometer recorder put out by Foxboro. The company has also developed a new, exceedingly simple method of attaching recorder charts and has brought out a temperature bulb which definitely localizes the recorder temperature at the tip of the bulb by the use of high-conducting aluminum at the tip and poorly conducting KA2 for the rest of the bulb.

Plant maintenance men will appreciate a new ammeter introduced by the Instrument Service Co., Hoboken, N. J. This device is light and portable, and does not have to be connected into the line. It operates by induction and draws no current. Readings are obtained by closing a pair of tongs about the conductor.

Gas Analyzer Uses Line Current

Something entirely new in thermal conductivity gas analyzers was exhibited by the Leeds & Northrup Co., Philadelphia, Pa. Previously it has been necessary to dry moisture-containing gases before analysis. The new instrument, which is intended only for CO_2 and other gases only slightly soluble in water, reverses the procedure and saturates the gas. Air, which is used as a reference gas, is also saturated. Because the instrument employs an alternating current bridge it operates directly from the line and requires no battery. This company has also developed two pressure transmitters for remote indication. One is a scale type where the pressure is weighed by an automatically balanced weight traveling on a scale beam. Transmission is accomplished by the traveling weight making contact with a slide wire which is part of a recording potentiometer circuit. In a modification of this device, the pressure is measured by a mercury manometer.

Mason Regulator Co., Boston, Mass., exhibited a number of control instruments which were equipped with compensating devices to limit hunting. A new temperature controller was compensated for pressure variations in the heating steam and for the control pressure applied to the diaphragm. The first tends to anticipate temperature variations while the second brings the control valve to its final position without overshooting. This second form of compensation is applied also to the company's pressure and flow controllers, the latter constituting a new line.

Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., showed two new temperature control instruments. One employs a fluid system to actuate a tilting mercury switch. The other, which is also applicable in pressure work, is used in conjunction with this company's proportioning motor control described some months ago in *Chem. & Met.* The instrument consists of a pressure or temperature sensitive device which

moves a contact over a slide wire that is part of a potentiometer circuit. This serves to control the movements of the motor and in turn to position the controlled valve.

Pyrometer Instrument Co., New York City, exhibited a new rapid-acting radiation pyrometer and recorder. Furnace radiation is absorbed by a minute thermocouple which is said to react instantly without time lag. The recorder utilizes a specially designed vibrating device, set in action by the alternating current used to drive the clock, to make and break contacts between paper and pen.

Republic Flow Meters Co., Chicago, Ill., exhibited a completely redesigned CO_2 meter provided with a large illuminated indicator dial. This concern has recently added a combination instrument for recording steam flow, percentage CO_2 and flue-gas temperature. For flow measurement the company has added an improved type of manometer designed to cover all ranges of differential pressure.

Completely redesigned temperature regulators of the self-contained type were shown by the Sarco Co., New York City. These regulators are liquid-filled and employ bellows tubing for the motor element of the thermostat and control valve.

Photoelectric Potentiometer Developed

C. J. Tagliabue Mfg. Co., Brooklyn, N. Y., showed an improved form of transmission for the flow meter announced recently in *Chem. & Met.* This is a magnetic transmission which eliminates all direct contact between the manometer and the indicator mechanism. Another development is an entirely new, photoelectrically balanced potentiometer pyrometer recorder. This instrument employs a mirror galvanometer which is automatically balanced by means of a single photoelectric cell.

Taylor Instrument Companies, Rochester, N. Y., showed a new form of capillary tubing for use in fluid-filled thermometer systems. The tubing bore is extremely accurate. Since the filler wire is made of invar, which has a negligible temperature coefficient of expansion, temperature changes along the capillary have no effect on the accuracy of the instrument since variation in the fluid is offset by variations in the tubing itself. This concern's entire line of temperature instruments has been redesigned.

New equipment for fluid handling had a number of interesting representatives. Chapman Valve Co., Indian Orchard, Mass., showed a rapid-closing, cone-type automatic check valve for use in the suction system of centrifugal pumps. The valve may be operated by hand, by hydraulic cylinder, or by motor. The valve may be controlled by a Venturi tube or control may depend on current failure or loss of pressure. Automatic priming of centrifugal pumps is the purpose of a device shown by the Skidmore Corp., St. Joseph, Mich. A float chamber attached to the pump suction accumulates sufficient air before the pump can lose its priming to actuate a mercury switch and start a small vacuum pump which exhausts the air. Foster Wheeler Corp., New York City, offered a new axial-flow pump for handling large volumes of water against low heads. This pump is said to combine the advantageous features of both propeller pumps and volute-type centrifugal pumps.

An interesting development in copper fittings for use with copper pipe was shown by the Chase Brass & Copper Co., Waterbury, Conn. These fittings are attached by sweating and are used industrially in any non-corrosive service for pressures to 500 lb. and temperatures to 250 deg. F.

New power-transmission equipment included two recently introduced motorized speed reducers. One of these, made by the Boston Gear Co., Boston, Mass., covered a range from ¼ to 3 hp. and ratios from 10:1 to 100:1. Foote Bros. Gear & Machine Co., Chicago, Ill., showed the other, together with a small ratchet operated stoker drive for speed variation in six steps. Alexander Bros., Philadelphia, Pa., have developed a novel motor base in which the motor platform rests on two half gears, which in turn are supported on racks. The device is used with short-center belt drives and in operation serves to maintain a predetermined tension on the belt regardless of stretching.

Hydraulic transmissions have become increasingly evident in recent years. One shown by the American Blower Corp., Detroit, Mich., was used in coupling one of its fans to the electric motor. The coupling is sold by the blower corporation but made by Hydraulic Couplings, Inc., Detroit, Mich. It permits variable speed from a constant speed motor so that the fan can operate most efficiently under all conditions. This coupling transmits power by the kinetic energy of oil which is discharged by an impeller directly against the vanes of a runner within the same casing. The quantity of oil within the system may be quickly varied, thus varying the speed of the driven section.

Falk Corp., Milwaukee, Wis., showed a new torque converter which has, so far, been built in sizes to 5 hp. It permits the gradual coupling of the motor to a load, at the same time absorbing shocks and limiting the load to the capacity of the motor. Its action does not depend on the use of friction bands.

Apparatus having to do with heating and cooling had several representatives. Babcock & Wilcox Co., New York City, showed one of its new heating tubes for mercury heat-transfer systems. This consists of a central downflow tube surrounded by a number of vapor tubes coiling up around it. This company has also developed a method for making boiler drums and process pressure vessels. Using a seamless drum as the starting point, the new process forces in the ends, not by hammering, but by a method similar to spinning. The end openings are then closed by manheads.

Carrier-York Corp., Newark, N. J., showed one of its new line of vacuum refrigerating outfits for industrial use. This is an extremely compact combination of evaporator, steam-jet vacuum producer and condenser. It is available in capacities from 3 to 35 tons of refrigeration and employs only one moving part, the centrifugal pump which circulates the cooled water.

L. J. Wing Mfg. Co., New York City, offered a number of improved unit heaters and a new process heater consisting of a fan and several banks of extended surface radiation enclosed within a casing.

Yarnall-Waring Co., Philadelphia, Pa., showed an entirely novel type of expansion joint for process and power steam lines. Previously, expansion joints of the slip type have required shutting down the pressure when repacking was necessary. The new joint employs a plastic packing material which is forced into the joint under high pressure, in a manner similar to that of pressure lubrication.

The trend toward stricter municipal control of air pollution was indicated by a new wetted-baffle type fly-ash eliminator, shown by the Riley Stoker Corp., Worcester, Mass. This device employs a large number of narrow, vertical baffles arranged like eliminator plates and subjected to a trickle of water.

New Softener Is Automatic

The Permutit Corp., New York City, exhibited a fully automatic zeolite water softener, capable of performing all of its operations of softening and regenerating without attention. Controlled by a meter, the device shuts off the flow of water to be softened, permits the entrance of regenerating brine, washes out the brine and reconnects the water supply.

American Brass Co., Bridgeport, Conn., attracted much attention with an exhibit of a new copper-beryllium alloy of exceptional strength. Using from 1 to 2¼ per cent beryllium the company has developed a range of products with elastic limits up to 170,000 lb. The alloys are extremely hard, susceptible to heat treatment, non-sparking, of high electrical conductivity and resistant to corrosion.

NEW EQUIPMENT

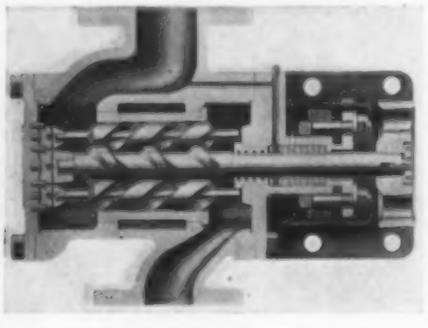
Positive Rotary Pump • Automatic Packaging Scale • Automatic Speed Changer • Pressure-Packed Expansion Joint • Redler Conveyor • Recording Hygrometer • Motor Reduction Unit • General-Service Pump Splash-Proof Motor • Automatic Water Softener • Enameled Pump Runners • Explosion-Resisting Starter • Non-Clogging Pump • Pulp Digester Strainer High-Capacity Welder • Glass-Lined Valve • Improved Fluid Meters • Humidity Controller • Manufacturers' Latest Publications

Positive Rotary Pump

Efficiencies of 80 to 90 per cent are claimed for a new positive, rotary pump which operates satisfactorily at standard motor speeds and even at turbine speeds. The pump, known as the De Laval-IMO, is manufactured by the DeLaval Steam Turbine Co., Trenton, N. J. It is available in sizes ranging from ½ to 700 gal. per minute and for pressures of 500 lb. per square inch.

The accompanying view illustrates the principle involved. Power is applied through a central power rotor which meshes with one or more sealing rotors of such form that they are propelled largely by fluid pressure with a minimum of mechanical contact. This action results from the ingenious shape of the threads, those of the power rotor being convex while those of the idler rotor (rotors) are concave.

Axial section of rotary positive pump



Among advantages claimed for the new pump are the following: Only one stuffing box is necessary; liquid velocity is low; flow is pulsationless; operation is quiet, even at high speeds.

Automatic Packaging Scale

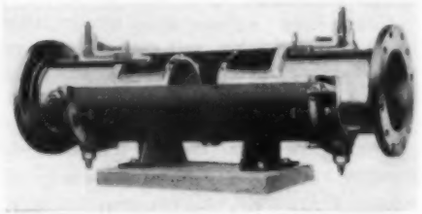
For the packaging of liquid and semi-solid materials, Toledo Precision Devices, Inc., Toledo, Ohio, has developed the new Toledo Tare Packaging Auto-Gage which consists of a Toledo Auto-Gage equipped with a photoelectric tube and an automatic tare device. The latter automatically adjusts the tare of the empty container. When this has been accomplished the phototube opens the feed valve, again closing it when the container is filled. From one to four automatic valves may be furnished.

Automatic Speed Changer

Link-Belt Co., 910 South Michigan Ave., Chicago, Ill., has announced the recent development of a variable speed transmission with automatic time-cycle control. The unit consists of a Link-Belt P.I.V. gear (described in *Chem. & Met.*, page 770, Dec., 1930) with a special speed-reduction unit mounted on top and connected by roller chain drives to the gear's constant speed shaft and to its control screw. Through the use of change gears in the speed reduction unit, the rate at which the control screw is rotated may be varied at will. When the device is operated, the speed of the controlled-speed shaft changes continuously until the limit of variation has been reached. Through the use of a handwheel, the device may be set for any desired starting speed of the variable-speed shaft, as well as reset to repeat the cycle.

Pressure-Packed Expansion Joints

Repacking under full steam-line pressure is possible with the new Gun-Pakt expansion joint recently introduced by the Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa. As appears from the accompanying cutaway view, the joint differs from the company's standard designs in that a plastic packing material



Expansion joint repackable under pressure

is employed which is renewed in a manner similar to pressure lubrication. This is accomplished by tightening the several screw-pressure guns built into the packing gland. The packing, which is prepared in pellets shaped to fit the cylinder, is made from long-fiber asbestos combined with an inert material in which high fire-test mineral oil is stored. Additional pellets may be added under pressure. Joints are available for any pressure within the range of modern steam practice.

Redler Conveyor

Stephens-Adamson Manufacturing Co., Aurora, Ill., announces that it has acquired exclusive United States rights for the manufacture of the Redler conveyor announced on page 571 of the October, 1932, issue of *Chem. & Met.* The company has exclusive sales rights in most fields, with the exception of food manufacture, where it has non-exclusive rights.

Recording Hygrometer

Direct recording in terms of relative humidity is a feature of a new recording hygrometer recently developed by the Bristol Co., Waterbury, Conn. The instrument, known as a "Humidigraph,"

employs a sensitive element consisting of wood fibers built up on a nickeled wire screen wound in the form of a spiral. Changes in relative humidity affect the hygroscopic element, creating a deformation which causes the free end to revolve about its axis, transmitting this motion to the recorder pen. Instruments are available in portable or non-portable cases for 4 or 8-in. charts, with or without a second pen for temperature.

Motor Reduction Unit

Standard speeds from 3.02 to 380 r.p.m. at the power takeoff are available through the use of a new line of motorized speed reducers announced by Allis-Chalmers Manufacturing Co., Milwaukee, Wis. A standard round-frame motor is mounted directly on the gear reducer housing. Helical gears are used, together with anti-friction bearings and automatic lubrication. Units can be supplied for wall, ceiling or vertical mounting as well as the standard floor mounting. Any type of motor may be supplied.

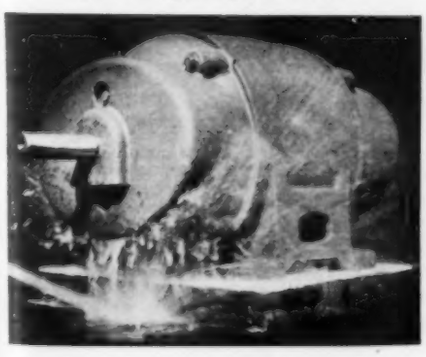
General-Service Pump

A new close-coupled centrifugal pump for general service in small and moderate capacities, for heads up to 150 ft. in a single-stage unit, has been announced by the Lawrence Pump & Engine Co., Lawrence, Mass. It is known as the Type E "Electropump." Couplings are eliminated and a special foundation is not required. The pump is self-contained, light in weight and requires little space. Sizes range from 1 to 2 in. suction and motor horsepowers from ¾ to 7½.

Splash-Proof Motor

What is said to be the first splash-proof motor, capable of preventing entrance of water splashed under high pressure from any angle, has been announced by the Louis Allis Co., Milwaukee, Wis. The motor is ventilated and its splash-proof characteristics are obtained through the use of a double baffle in an elliptical-shaped air passage in each endbell. The construction permits the passage of air, but traps and drains the water splashed into the air openings. Shaft guards prevent water from entering the bearing chambers.

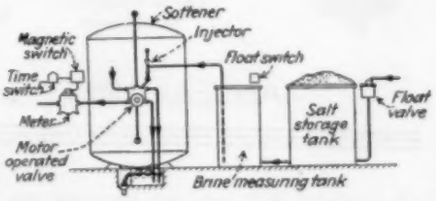
Test of splash-proof motor



This company has also announced a line of motorized speed reducers in sizes from ¾ to 75 hp. with output speeds ranging from 4 to 400 r.p.m. In the so-called flexible style, the entire motor, without change, is mounted on the gear casing. This is used with ventilated motors. For open or closed non-ventilated motors, an integral type is used in which the motor endbell is removed.

Automatic Water Softener

Fully automatic operation has been achieved in a new industrial zeolite water softener recently announced by the Permutit Co., 440 Fourth Ave., New York City. The accompanying drawing indicates the principal parts of this new equipment. At the end of the softening run, the meter actuates electrical controls which cut the softener out of operation, backwash it for a predetermined period, admit a regulated amount of brine to accomplish regeneration, rinse off the hardness salts to waste, and throw the softener back into service. The company will supply new models with automatic control and announces that it can also apply automatic control to existent down-flow softeners.



Water softener employing fully automatic control

Enameled Pump Runners

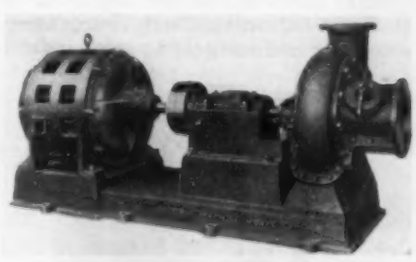
After several years of development, the Johnston Pump Co., 2324 East 49th St., Los Angeles, Calif., has announced perfection of a method of coating the runners and bowls of turbine-type, deep-well centrifugal pumps with porcelain enamel. This coating not only supplies protection against corrosion and abrasion, but is said to increase the efficiency of the pump approximately 5 per cent. This increase in efficiency arises from the greater smoothness of the parts in contact with the fluid. Heretofore, it has been necessary for manufacturers to rely on castings in which complete smoothness has been unattainable. The enamel coating, however, is said to produce a glass-hard, glass-smooth surface. In one pump test reported by the company, a peak efficiency of 79.7 per cent was obtained with enameled impellers and pump cases as compared with a peak efficiency of 74.5 per cent using smooth, hand-dressed bronze impellers in plain, cast-iron pump cases.

Explosion-Resisting Starter

A new line of explosion-resisting linestarters has been announced by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. These starters, which have been developed for use in Class 1, Group D hazardous locations, *i.e.*, in locations where highly flammable, volatile liquids or gases are manufactured, used or handled, are intended primarily for use in oil refineries, dye plants and similar locations. They are mounted in heavy cast-iron cabinets with wide flanges and employ De-ion contactors and combination hand and automatic reset thermal-overload relays. They are provided either with separate or built-in pushbuttons.

Non-Clogging Pump

For handling pulp of both heavy and light consistencies, Morris Machine Works, Baldwinsville, N. Y., has announced the development of a new non-clogging centrifugal pump. The suction nozzle, impeller and pump passages are said to be of special form, designed to secure uniform conversion of the velocity of the material to pressure with minimum friction, slippage or separation of water from pulp. Impellers of various types have been developed for different kinds and consistencies of stock. Balance of end thrust, adequate support for the heavy shaft, and convenience of access to the pump interior are all said to be special features of the design.



Direction-connected stock pump

Pulp Digester Strainer

Exclusive manufacturing and sales rights in the United States for the patented Panzl strainer for pulp digesters has been announced by the Duriron Co., Dayton, Ohio. The strainer is a ring which is permanently attached be-

tween the digester body and cover. The connections are made to the strainer. It is claimed that the strainer is positively non-clogging, thus reducing loading time and labor cost.

High-Capacity Welder

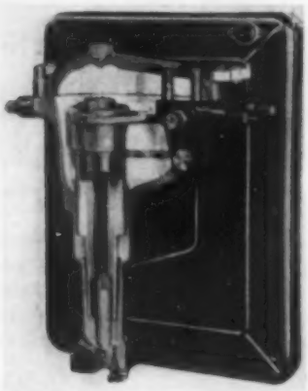
More weld deposit per kilowatt-hour, faster welding and lower unit cost of welding are claims made by the Lincoln Electric Co., Cleveland, Ohio, for its new "Shield Arc" welder. This machine is said effectively to level out fluctuations in the welding current, permitting a 60 per cent greater kilowatt rating than before. The new machine is fully inclosed and is available in a combination portable-stationary model of 300, 400 or 600 amp.

Glass-Lined Valve

The Hills-McCanna "Saunders" valve, manufactured by the Hills-McCanna Co., 2349 Nelson St., Chicago, Ill., and described in the March, 1932, issue of *Chem. & Met.*, is now available with glass and rubber linings, according to a recent announcement of the manufacturer. It will be recalled that the feature of this valve is a diaphragm which replaces the plug or disk ordinarily used in valves.

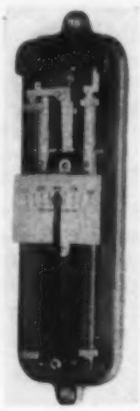
Improved Fluid Meters

Manufacture of a new line of fluid meters for measurement of steam, water, gases and other fluids, has been announced by the Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio. Three general combinations are available, including indicating and integrating; recording and integrating; and indicating, recording and integrating. The measuring device used in these combinations is illustrated in the accompanying view. It consists of a further refinement of this company's mercury-sealed Ledoux bell which responds to differentials created by an orifice or Venturi tube, giving a straight-line flow relationship.



Cutaway view of flow meter bell

The new line makes use of a new type of integrator which is said to be of high accuracy and considerable simplicity. Four times a minute the integrator mechanism is adjusted to the prevailing rate of flow, increasing the counter reading by the proper increment.



Contact-making humidistat

Humidity Controller

An accompanying illustration shows a new hygroscopic controller, the Friez Humidistat, manufactured by Julien P. Friez & Sons, Baltimore, Md. The sensitive element consists of two groups of human hairs which cooperate through a balancing linkage to open or close electric contacts whenever variations in humidity change the length of the sensitive element. It is claimed that the device will control humidity with exceptional accuracy within the range from 20 to 100 per cent humidity. The instrument contacts will carry 25 watts at voltages up to 110 volts.

This company has also announced a new humidity indicator built along lines similar to the controller. The instrument is said to require no adjustment or lubrication and is designed for easy reading of humidities from 20 to 100 per cent.

Oil-Proof Hose

Manhattan Rubber Manufacturing Division, Passaic, N. J., has announced the development of rubber tubing and hose lined with a compound called Paranite G.O.P. The base of this compound is Thiocol which may be combined with oil-resisting rubber in various proportions. Linings so produced are said to be highly resistant to gasoline and other petroleum products.

MANUFACTURERS' LATEST PUBLICATIONS

Chemicals. The Grasselli Chemical Co., Cleveland, Ohio—Folder on this company's C.P. reagents, listing analyses.

Compressors. Sullivan Machinery Co., 400 North Michigan Ave., Chicago, Ill.—Catalog 88-A—32 pages on advantages of and new developments in angle-compound air compressors made by this company.

Control. Sarco Co., 483 Madison Ave., New York City—Bulletin 54—4 pages on temperature regulators for brine control in refrigeration.

Conveyors. Stephens-Adamson Mfg. Co., Aurora, Ill.—20 pages on the Redler conveyor for which manufacturing and sales rights have recently been acquired by this company.

Dust Collecting. Pangborn Corp., Hagerstown, Md.—Leaflet announcing a portfolio of 4 bulletins on dust collecting equipment and accessories.

Equipment. Sun Shipbuilding & Drydock Co., Chester, Pa.—Catalog 101—20 pages on types of equipment made by and facilities of this company. Covers equipment for refineries, cement plants, chemical plants, paper mills and gas plants.

Fluid Handling. DeLaval Steam Turbine Co., Trenton, N. J.—Publications as follows: Catalog C-6, 4 pages on propeller pumps; Catalog L-10, 8 pages on this company's new line of IMO rotary displacement pumps; 4-page reprint on "Efficient Suction Head for Centrifugal Pump Operation."

Heating Units. Hoskins Mfg. Co., Detroit, Mich.—Ingenious calculator for determining the length of Chromel A resistance wire required to give the desired wattage in heating units. This "heating unit calculator" carries complete instructions for use.

Labels. Robert A. Haag, 38 Murray St., New York City—Specimen cover and sample leaf of new book of perforated, gummed chemical labels, to be issued by chemical manufacturers with or without their own advertising on cover.

Motors. Louis Allis Co., Milwaukee, Wis.—Bulletin 512—Folder describing this company's new line of splash-proof motors.

Motors. Lincoln Electric Co., Cleveland, Ohio—Folder describing features of this company's motors which give it added capacity.

Motors. Sterling Electric Motors, Inc., Telegraph Road at Atlantic Blvd., Los Angeles, Calif.—8-page folder illustrating types and applications of this company's line of motorized speed reducers.

Pumps. Pennsylvania Pump & Compressor Co., Easton, Pa.—Bulletin 218—12 pages on single-stage, close-coupled centrifugal pumps.

Rectifiers. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Bulletin C-1907-B—16 pages on the new sectional-type mercury-arc rectifiers made by this company.

Refractories. General Refractories Co., Philadelphia, Pa.—Bulletin recording experience of one user with "Ritex," a new magnesite brick developed by this company for use in cement kilns.

Refrigeration. Kerotest Mfg. Co., 2525 Liberty Ave., Pittsburgh, Pa.—Catalog 5—48 pages on forged brass valves and fittings for mechanical refrigeration.

Sieves. Newark Wire Cloth Co., 351 Verona Ave., Newark, N. J.—Folder describing standard cornerless sieves and automatic sieve shakers.

Soda Ash. Columbia Alkali Corp., Empire State Building, New York City—30 pages on the use of soda ash in the glass industry.

Sodium Silicate. Philadelphia Quartz Co., Philadelphia, Pa.—Bulletin 171—8 pages on the types, uses and shipment of silicate of soda.

Steam Traps. Armstrong Machine Works, Three Rivers, Mich.—Catalog G—28 pages, fully, clearly and attractively presenting information on the types and uses of this company's steam traps.

Stills. F. J. Stokes Machine Co., Tabor Road, Olney P. O., Philadelphia, Pa.—Folder describing this company's new line of 1-gal. automatic water stills.

Still Tubes. Spang, Chalfant & Co., Clark Bldg., Pittsburgh, Pa.—19 pages on physical and chemical properties and specifications of 4-6 per cent chromium seamless still tubes made by this company.

Welding. Harnischfeger Corp., Milwaukee, Wis.—Bulletin HW-2—20 pages on this company's electric-arc welding equipment.

NEWS OF THE INDUSTRY

Society activities include twenty-fifth anniversary meeting of A.I.Ch.E., annual meeting of A.S.M.E. coinciding with the week of the Power Show, and election of officers of New York section of A.C.S. Court News comprised decisions upholding patent of Commercial Solvents Corp. and rejecting DuPont claims of infringement of Flaherty patent

Economics, Engineering Compete For A.S.M.E. Interest

As is natural in a time of depression, economic subjects bulked large in the program of the 53d annual meeting of the American Society of Mechanical Engineers, held in New York from Dec. 5 to 8. Every phase of the program stressed the need for getting back to fundamentals in economics and business, in engineering and in human relations. It was symptomatic that the Society's management division was the most active of all the groups in point of the number of its sessions.

As a result of the election of officers held before the meeting by mail ballot, Dean A. A. Potter, of the Schools of Engineering of Purdue University, became president of the Society. The vice-presidents elected were: Harold V. Coes, of New York; J. D. Cunningham, of Chicago; and C. F. Hirschfeld, of Detroit. The managers elected were: A. D. Bailey, of Chicago; J. A. Hunter, of the University of Colorado; and Dean R. L. Sackett, of Pennsylvania State College.

Among the technical sessions, the one of most concern to chemical engineers was a luncheon meeting of the executive officers and subchairmen of the process industries committee. Chairman C. E. Harrington, of the University of Buffalo, stated that the several years of preliminary work of the committee had been unusually productive and were about to come to fruition in the anticipated early recognition of the group as a professional division in good standing. The reports of the several subchairmen indicated sustained interest in a process division on the part of many A.S.M.E. members.

Court Finds for Glidden In Lacquer Suit

In his decision on Dec. 7, 1932, handed down in the United States District Court, Eastern District of New York, Judge Marcus B. Campbell found for the defendant, The Glidden Co., in the suit brought by E. I. duPont de Nemours & Co. over the alleged infringement of the Flaherty patent, Reissue 16,803, owned by duPont. The patent in suit relates to the use of low-viscosity nitrocellulose in lacquers. It covers a product but not a method or process. The plaintiff did not contend that the defendant was infringing the method of reducing the visçosity of the nitrocellulose which was referred to in the patent, but rather that the defendant was using a nitrocellulose base of lower viscosity than a certain upper limit defined in the claims of the patent in suit. The method referred to in the patent was not first disclosed in the patent but was a prior invention, that of Pitman, U.S.P. 1,639,619. The claim of the patent was, therefore, that the use for lacquer films of low-viscosity nitrocellulose made by the method of the prior patent or by other methods was novel and patentable.

In the decision, the Court held that the Flaherty patent was invalid for lack of invention. He held that it had been known before the start of Flaherty's work that low-viscosity nitrocellulose was desirable for use in lacquers because it would permit the solution to contain more nitrocellulose. Earlier patents, namely those of Grove and Ward, B.P. 128,659 (1919) and Carlsson and Thall (U.S.P. of 1921) were held to anticipate the Flaherty patent in this regard. It was likewise found that the early work of the Atlas Zapon Co. in 1919 and of the Perry-Austen Co. in 1914 were anticipations.

It was brought out by duPont during the trial that the Flaherty patent was the basic patent protecting the manufacture of Duco. Prior to July 1, 1932, the company had granted licenses under this patent and four others to a number of manufacturers. This arrangement had not been accepted by the Glidden Co. During this period duPont collected $124,320 in royalties on the group of licenses.

A second suit for infringement of the Flaherty patent is being brought by duPont against the Jones-Dabney Co., of Louisville.

A. C. S. New York Section Elects Officers

Officers elected by the New York section of the American Chemical Society at its meeting on Dec. 7 included the following: chairman, Victor K. La Mer, professor of chemistry at Columbia University; vice-chairman, J. M. Weiss, president of Weiss & Downs, Inc., New York; secretary-treasurer, David P. Morgan, Jr., of Scudder, Stevens & Clarke, New York; and members of the executive committee: Walter S. Landis, vice-president of the American Cyanamid Co., who is the retiring chairman of the section; Prof. D. D. Jackson, of Columbia University; Prof. Arthur E. Hill, of New York University; and D. H. Killeffer, consultant, of New York. Councillors to the number of 15 were also chosen.

Lammot du Pont Luncheon Guest of Chemists' Club

The New York Chemists' Club on December 10 held the first of a series of special luncheons. Lammot du Pont, president of E. I. du Pont de Nemours & Co. and of the Manufacturing Chemists' Association was the guest of honor and speaker.

A.I.Ch.E. Holds Birthday Party In Washington

Throwing aside the matured dignity which the American Institute of Chemical Engineers has accumulated in the twenty-five years since it was founded in Philadelphia, June 22, 1908, more than 200 of its members and guests joined in an informal birthday party at the Hotel Washington, Washington, D. C., on Dec. 8, 1932. The event proved a high-spot of the social sessions of the twenty-fifth annual meeting of the Institute, the technical program of which is reported elsewhere in this issue.

To Prof. John C. Olsen, who has served as an officer of the organization during the whole period of its existence, went the honor of cutting the huge birthday cake. Prof. Alfred H. White spoke interestingly of "Some Presidents I Have Known," paying a special tribute to the first two presidents—Dr. Samuel P. Sadtler and Dr. Charles F. McKenna. Dr. H. C. Parmelee, to whom the toastmaster, President John V. N. Dorr, had assigned the subject "Reminiscences of Personalities," set up a new chemical engineering Hall of Fame—the candidates qualifying on the basis of certain extra-professional activities unknown to most of the membership. Among those to qualify were the late Dr. Charles F. Chandler, Dr. Leo H. Baekeland, Dr. M. C. Whitaker, Dr. M. H. Ittner, Dr. A. E. Marshall and Dr. Ellery L. Wilson, Dr. D. D. Jackson and Dr. James Lawrence.

A souvenir pamphlet entitled "The Silver Anniversary of Chemical Engineering in America" was distributed after Dean Webster N. Jones of Carnegie Institute of Technology had embarrassed its editor by reading an extended "obituary" and presenting him with a silver medal on behalf of the Institute.

A well received feature of the evening's entertainment was a musical program arranged by Mrs. W. E. Emley, in which the daughters of local members, appropriately costumed, sang songs of twenty-five years ago. An informal quartette consisting of Harrison E. Howe, George P. Adamson, E. R. Weidlein and Ellery L. Wilson also sang to their own satisfaction and to the amusement of the audience. R. S. McBride served as general chairman of the local committee, H. E. Howe was vice-chairman and W. M. Corse, treasurer.

At the annual business meeting on Dec. 7, announcement was made of the re-election of President John Van Nostrand Dorr, Vice-President Albert E. Marshall, and Secretary and Executive Secretary Frederic J. Le Maistre. C. R. Downs, H. E. Howe, S. D. Kirkpatrick and F. W. Willard were elected directors of the Institute to succeed A. A. Backus, G. J. Esselen, Crosby Field and F. C. Zeisberg, whose terms of office expired with this meeting.

The next meeting of the Institute is to be held in Chicago on June 14, 15, and 16, 1933, immediately in advance of Engineering Week at the Century of Progress Exposition.

Freeport Sulphur Will Build Plant in Louisiana

Construction of a sulphur mining plant for the extraction of the mineral from the caprock of the Lake Washington (Lake Grande Ecaille), in Plaquemines parish, will be undertaken soon by the Freeport Sulphur Company, according to a statement issued by attorneys representing the company. The announcement follows the recent adoption of a constitutional amendment increasing the severance tax on sulphur by 50 per cent and exempting it from ad valorem taxes while in the ground.

The plant will include: power plant, shops, office, laboratory, water treating equipment, housing facilities for employees, and roads, pipe lines, and reservoirs for fuel and water as well as storage bins. Information concerning the plans was published on authorization of E. L. Norton, president of the company.

The site is located on the shore of the lake, which is a tidewater inlet connected with the Gulf of Mexico. Though the waters of the region are shallow, barge operation is possible, petroleum being brought to refinery points by barge from several wells.

Company Formed to Finance Equipment Purchases

Paralleling the long-continued period of neglected maintenance, there has been an intense effort on the part of manufacturers to develop equipment that will produce at lower costs. This activity has been so successful that much existing industrial equipment has been rendered obsolete.

Obviously there should be some agency to supply funds to such companies to parallel and supplement the work of the Robertson committee and the R.F.C., by taking care of the needs of the industrials that lie beyond the scope of these governmental instrumentalities.

One plan has already taken shape in the formation of Improved Industries Corporation, of 521 Fifth Avenue, New York. This company has been organized to finance without notes, in whole or in part, the purchase and installation of equipment needed by industrial plants to carry out modernization programs, and its plans have been approved by a number of the country's leading manufacturing firms.

Commercial Solvents Upheld On Weizmann Patent

The United States Circuit Court of Appeals for the Third Circuit sustained the decision of the District Court of the United States for the district of Delaware in the lawsuit of the Guaranty Trust Co. of New York, the Butacet Corporation and the Commercial Solvents Corporation against the Union Solvents Corporation.

This was an appeal made by the Union Solvents Corporation from a decree of the District Court of the United States holding valid and infringed claims 1 and 3 of the United States Patent No. 1,315,585, issued to Charles Weizmann and held by the Commercial Solvents Corporation, Sept. 9, 1919, relating to the production of acetone and butyl alcohol.

The questions of the validity and infringement of the claims in suit were in issue. The defendant, the Union Solvents Corporation, said they were invalid, but that even if valid it did not infringe.

The argument in suport of these defenses was argued in the District Court of the United States and was presented in the Circuit Court of Appeals, but the opinion of the District Judge adequately answered the arguments and it was agreed that the invention disclosed in the patent created a new and important commercial enterprise.

Funds Sought to Continue Research on Coatings

A research program for investigating the protective value of electroplated coatings on steel has been underway for several years at the U. S. Bureau of Standards. Worthwhile results have already been obtained on such factors as the throwing power and porosity in nickel and chromium depositions. It is expected that inspection and examination at intervals during the next twelve months of the 7,000 specimens of copper, nickel, chromium, and zinc coatings now under test in various sections of the country will supply sufficient data upon which improved plating standards may be established.

In order to expedite the investigation the American Electroplaters' Society has supported a research associate at the Bureau, and more recently the American Society for Testing Materials has also assisted in the work. At present, however, the funds for this purpose are almost exhausted, and the sponsoring society is asking the manufacturers and users of electroplated coatings to subscribe the funds to continue this work, in order that the investment of the past will not be lost.

NEWS FROM WASHINGTON

By PAUL WOOTON
Washington Correspondent of Chem. & Met.

ACCEPTANCE of strategic raw materials as part payment on war debts is an alternative that has been considered by the administration and may be proposed when Congress takes up this vexing question. Only materials serving a national purpose would be eligible but volume might easily run the total up to $100,000,000 or more. Most vital from this standpoint are manganese, chromium, tin, rubber, nickel, mercury, tungsten, mica, and coconut shell charcoal.

Large stocks of manganese, tin, rubber, nickel and mercury now overhang the world market and their purchase and storage in considerable quantities at present record low prices would tend presumably to stimulate the price of new production and restore purchasing power in producing countries to some extent. Domestic industry would not be affected as those materials which exist in this country can only be produced under the artificial stimulation of war-time prices.

Payment would involve no outflow of money as in the case of gold because debtor nations would pay producers in their own depreciated currency. The United States might agree to utilize the stocks only in the event of national emergency but if not, the stocks held by this government would forever discourage foreign cartels from arbitrary price-fixing.

Many Commodities Available

England, France, Italy and perhaps other nations could discharge part of their current debt obligation in this manner. Great Britain could draw 1,250,000 tons of manganese ore at $10 a ton and 3,000 tons of mica from India; 15,000 tons of coconut charcoal at 1.5c. a lb. from Ceylon; 40,000 tons of nickel at 35c. a lb. from Canada; 10,000 tons of tungsten ore at $240 a ton from Australia and Burma; 300,000 tons of rubber at 4c. a lb. and 25,000 tons of tin at 22c. a lb. from Malaya; France could put up 250,000 tons of chromium ore at $18 a ton from New Caledonia, and Italy, 25,000 flasks of mercury at $45 a flask. The current market prices quoted compare with war-time prices of $55 per ton for manganese ore; $70 per ton for chromium ore; $120 per flask for mercury; 40c. a lb. for nickel; $1,500 a ton for tungsten ore; 85c. a lb. for tin and 70c. a lb. for rubber.

The total falls short of $100 millions but could be extended to include a larger volume of the same commodities or other commodities from other countries.

President Hoover's recommendations for reorganizing the Government establishment are regarded as a mere gesture as Congress probably will reject them en bloc. Consideration of the various proposals on their merits might carry Congress beyond expiration of the 60-day period when, under the law enacted last June, they become effective automatically unless its acts. To be on the safe side, the Democratic leadership in the Senate and House are expected to force rejection of the whole scheme by blanket resolution. There remains only the possibility that Republican stalwarts in the Senate will filibuster to prevent the passage of such a resolution within the time that Congress can intervene to upset the plan.

In various phases of the government's functions, concerning principally public land, public works and public health, President Hoover's recommendations for reorganization and consolidation are far-reaching but there is little that is of profound importance to industry and trade and nothing which directly concerns either the chemical or metal industries.

There had been some expectation that the Food and Drug Administration might be transferred from the Department of Agriculture to the Public Health Service because of the weapons that it brandishes in the defense of the nation's health but this organization was not disturbed. The Public Health Service, now in the Treasury Department, would be transferred to a Division of Education, Health and Recreation in the Interior Department.

The Bureau of Chemistry

The Bureau of Chemistry and Soils and the Biological Survey are assigned to a Division of Land Utilization which would be created in the Department of Agriculture. This new division also would embrace the Forest Service, the General Land Office, and the functions of the Committee on Conservation and Administration of the Public Domain, that in future would serve in an advisory capacity.

The Federal Oil Conservation Board would be abolished and its function transferred to the Bureau of Mines which is regarded by Mr. Hoover as well qualified to carry on the studies of petroleum production, probable demand and future supply with a view to providing means for promoting equitable conservation.

Because phosphate and superphosphate are both on the free list, adoption by the Senate of the resolution of Senator Walsh, of Montana, directing the Tariff Commission to investigate comparative domestic and Canadian production costs under Section 336 of the 1930 tariff has no force and effect. President Hoover has no authority under the flexible tariff to transfer any product from the free to the dutiable list. In this case only Congress can act on the Commission's findings and tariff revision is an unmentionable subject on Capitol Hill just now.

The Chemical Corps would be the new cognomen of the Chemical Warfare Service of the Army if Maj. Gen. H. L. Gilchrist, its chief, had his way. Expanding cooperation with private industry was noted in Maj. Gen. Gilchrist's annual report. He recommended construction at the Edgewood (Md.) depot of buildings for safe storage of chemical munitions and administration purposes.

Tariff Reductions Sought

Applications looking for a reduction in duties on ferruginous manganese ore and crystalline flake graphite have been dismissed by the Tariff Commission. The Tananarive, Madagascar, Chamber of Commerce sought a cut in the 1.65c. per lb. duty on graphite and William W. Hearne, Inc., Philadelphia, contended that the present duty of 1c. per lb. on metallic manganese was too high.

Applied economy was the theme of the recent conventions in Washington of the American Paint & Varnish Manufacturers Association and the National Paint, Oil & Varnish Association. A cost-finding survey in conjunction with the Department of Commerce was recommended. Scientific cost accounting linked with rigid budgetary control was prescribed by H. L. Wilkinson, of the stabilization committee, and other speakers, as the keystone of the program for maintaining the paint industry's position. Continued policing of unfair competition and vigorous promotion of the "save the surface" and "clean up and paint up" campaigns, within budgetary limitations, were advocated. Joint sessions of both associations were a feature of the conventions but complete amalgamation of the manufacturers' and distributors' organizations was postponed on the recommendation of the committee charged to consider this proposal. James F. Kurfees, of Louisville, was elected president of the A. P. & V. M. A. and Samuel R. Matlack, of Philadelphia, was elected president of the N. P. O. & V. A.

NEWS FROM ABROAD

By Special Correspondents of Chem. & Met. at London, Berlin and Paris

London

FINANCIAL and political difficulties of the moment have again revived interest and rumors relating to the manufacture of synthetic gold, and there has even been an attempt to raise money for the operation of an Italian process, protected by English Letters Patent, by which it is claimed that gold can be made from iron ore. Far less fantastic and of more than passing interest was Dr. Herbert Levinstein's suggestion in a recent lecture, that it would have been best immediately after the armistice to tackle seriously and comprehensively the development of the Empire's gold resources in order to make the 220-tons of gold needed to pay off the American debt. Had we contracted to pay the debt in bricks, said Dr. Levinstein, surely we should not have pulled down our houses and shipped the bricks, but we would have started numerous brick making factories.

In effect something of this sort is going on at present; the high value of gold is enabling new producers to open up successfully even on lower grade ore. An example is perhaps the Wiluna Gold Corporation of Western Australia, which will soon be milling 40,000 tons per month of ore worth about $7 per ton, and here there is an outstanding example of modern methods, inasmuch as the percentage recovery in all departments even on low grade ore has been increased to a material extent, partly by use of an unusual flotation ingredient. If modern geophysical methods should enable new and really extensive goldfields to be discovered in the Empire capable of being developed and exploited at low cost, their operation as a British Government enterprise for the paying of debt would raise serious and incalculable problems of great interest to chemical engineers, and yet by no means beyond the bounds of possibility.

The patent litigation between British Celanese and Courtaulds, Ltd., is likely to be a protracted affair, which is being followed with the very closest attention by other rayon interests. The hearing has now lasted twenty days, and Mr. Whitehead, K. C., has only just opened the case for the defence. During the course of the examination of the plaintiff's expert witnesses, the claim for infringement of one of the patents relating to a pump was abandoned, and from all accounts cross-examination appears to have been fairly effective in regard to the others, which relate to cap spinning, downward spinning in a cabinet designed for rapid evaporation of solvent, and to lubrication and spinning methods respectively. Without commenting in any way upon the merits of the case, it may be said that the general atmosphere indicates that the Celanese interests have drafted their claims so broadly as to invite attack by reference to the prior art, and that Courtaulds, Ltd., may be able to show that in law, at any rate, there has been no substantial infringement, nor have they used much which was not common knowledge as distinct from invention.

On the other hand, one cannot help feeling that in establishing manufacture successfully on a commercial scale, the Celanese Company was definitely a pioneer worthy of consideration, but it could be argued that having had ample time to develop and market their undeniably excellent products, they should be able to depend upon quality, marketing and manufacturing experience, rather than upon extensive patentation.

The announcements made by Tootal Broadhurst Lee Company in regard to their new so-called "creaseless" materials, are reported to be based on the incorporation of a synthetic resin in the textile material, subsequent to bleaching, dyeing or printing, the average amount added being 15 per cent by weight. In other cases phenol and urea formaldehyde resins have been used for exterior coating and before finishing. The process appears to increase both the dry and wet strength of the material and to reduce laundry shrinking, and if this new development enables crepe and voile fabrics to be restored after laundering, there opens up a new field of development in many directions.

In the first Hinchley Memorial Lecture of the Institution of Chemical Engineers, Mr. Tizard made an interesting reference to recent research for controlling the rate of oxidation of lubricating oil for aircraft engines. He showed that the addition of a small quantity of aniline completely stopped oxidation under certain conditions and also that the presence of iron was useful. In future it may be that lubricating oils for such purposes will have to be supplied to a definite chemical specification.

A London metal firm recently received an order for rods containing 55 per cent of zinc and 45 per cent of lead. When the ingot was passed through an extrusion machine, the two metals separated, the zinc coming out as rods and finally the lead came out practically in the form of shrapnel bullets with fatal results to one of the workers. Had a metallurgical chemist been available at this factory, the accident would probably have been avoided, and the publicity given should not only point a warning, but both here and elsewhere may well emphasize the ever widening field of usefulness of chemists in every branch of industry.

A useful supplement has just been published to the "Chemical Engineering & Chemical Catalogue" under the title of "Who Supplies." A feature is a German-English Chemical Dictionary, the apparent object of which is to enable buyers who only understand German to find the corresponding names of the English equivalents, and thereby to find the names of the appropriate suppliers. The utility of this seems doubtful and the German wording and translation is by no means free from mistakes; nevertheless the idea is of interest and shows enterprise in troublous times.

Berlin

THE following statements by Geheimrat P. Klöckner regarding the prospects for the mining industry and for commerce in general are quite informative. The year about ended was the worst experienced since the eighties; during the year the production sank to the following levels: Coal, to 34 per cent of capacity, compared with 52 per cent in 1930-31; ingot steel to 25 per cent (35 per cent in 1930-31); pig iron to 15 per cent (31 per cent in 1930-31). In addition domestic prices for these products dropped 10-12 RM. and the export price 25 RM. per ton, compared with the preceding year. These prices are 10 and 40 per cent lower, respectively, than those of the last pre-war period, while wages and salaries have increased 40 per cent, and expenditures for taxes and social work have gone up 100 per cent. In regard to the future, Klückner expresses confidence for his own plants as well as for industry in general. Increased activity has already manifested itself in larger coal deliveries, in higher consumption of pig iron, improved demand and higher prices for scrap, in Germany as well as abroad, a reduction in enforced lay-offs in the collieries dur-

ing the last weeks, a slow re-employment of workers, and an increase in car loadings.

I. G. Farbenindustrie's report for the third quarter also sounds a more encouraging note. In spite of continued and partly increasing difficulties in international exchange of goods by tariff increases, important restrictions, quota regulations and other obstructions, the downward tendency of the export figures in the company's various undertakings ceased toward the end of the quarter, and for some products an increase may even be noticed. To what extent workers are to be re-employed has not yet been decided, on account of the extended relief work in force at the many plants of the company. Sales of chemicals by I. G. do not quite equal those for the second quarter, although the last weeks showed many signs of improvement; for nitrate fertilizers the third quarter showed a ten per cent increase over the preceding year. Leunabenzine is again produced at a rate of 100,000 tons a year. Deliveries of crude oil from Volkenroda have not come up to expectation, but the need has been amply met with tar and other crude oils. A seasonal increase in the domestic demand for photographic chemicals has taken place, but exports have been affected by increased tariffs and falling exchange rates. Artificial silk has also shown slight improvement.

Deutsche Gasolin-A.G., subsidiary of I. G. Farbenindustrie shows a loss. Although production figures are not unfavorable, the prices obtained for most of the company's products were below cost of production. Industrial sales again increased, especially of Leuna-benzin. Curtailed activities in the paving field, and financial difficulties of states and municipalities restricting sales of asphalt, have caused a temporary shut-down of the Emmerich plant. For lubricants, market conditions are also poor.

Exporters are interested in the Iraq oilfields, as a German group (Otto Wolf, Mannesmann Pipe Works, Vereinigte Stahlwerke, and Gutehoffnungshütte) is participating in the construction of a pipe line to Alexandrette for the concessions of British Oil Development. As preliminary work has proceeded to a point where actual construction may start early in 1933 German industry is looking forward to an appreciable increase in activities. Deliveries of drilling machinery and tank steamers are also included.

The Atrament process, a new method for rust proofing iron, has been developed by I. G. Farbenindustrie. Treatment in a phosphate solution produces an insoluble layer of phosphate of exceptional density (in this respect the method resembles the Parkerizing process). The operation which is very simple, consists in the heating of the objects in a solution, the composition of which is not disclosed, for half an hour to one hour, near the boiling point. Careful removal of all dirt and grease prior to this treatment is essential. If necessary the objects may be given a further treatment by a blackening process, followed by light oiling. Fine expensive machinery parts, for typewriters, bicycles, automobiles, watches, and electrical apparatus are treated by this method, and it may also be applied to less expensive parts such as screws and springs.

Professor Schwalbe of the Eberswalde School of Forestry is recommending a cheap method for fire proofing wood. The wood is impregnated with formic acid or sodium acetate addition of dinatriumphosphate. By carbonizing the impregnated wood the low-melting salts are fused (melting points 253-319 deg. C.) A further increase in the temperature causes the salts to decompose with formation of soda, which soaks through the carbon and makes it very hard to burn. The process is cheap; a surface of one square meter may be treated with sodium acetate and a little dinatrium phosphate at a cost of about 0.07 RM. Sodium acetate is produced in the field by dry distillation of wood, and the method proposed should be of a great interest to the wood distillation industry, as the weak solution of crude acetic acid may be used without evaporation, by conversion into a salt that may be crystallized with little expense.

Paris

AS THE end of the year approaches it may be interesting to take a brief review of the economic situation, which remains unsatisfactory, but which shows slight signs of improvement. Certain gains in the chemical industry during September have been maintained, with a slight increase in prices in certain fields, an increase which, in most cases is more a readjustment. In fact, some fields are exhibiting prices below pre-war levels, as in the superphosphate industry, where the index is 4.5, and in the nitrogen fertilizer industry, with an index 2.8; the index for currency deflation is 5.

For this reason certain nitrogen fertilizers are offered to agriculture at a price very close to the cost of production, a fact which explains the difficult position of certain companies, and the large deficits in many financial statements. Thus Sté. La Nitrogène had a deficit of 6,700,000 fr. during the last period; L'Azote Français, with previous losses, showed a deficit of 50,000,000 fr.; Société des Produits Azotés showed no profit, although the net profit for the preceding period was 2,400,000 fr., with a capital of 33,000,000 fr. Generally speaking, all nitrogen producers are said to show drastic reductions in earnings compared with the previous period, and it appears difficult to lower cost of production to any appreciable extent. On the other hand, the sale price can hardly be advanced, in view of the low prices on agricultural products, especially wheat. In this connection the increase in the consumption of cyanamide is interesting. A sales office has been instituted, including the principal French producers. The Société des Produits Azotès has been entrusted with a good deal of authority in the management of the new office.

An important recovery has taken place in the textile industry, and the northern woolen mills in particular are at times running as before the crisis. Rayon manufacturers are operating on a good scale, but prices are not satisfactory. Nevertheless, the improved condition in this field has resulted in an increased production of bleaching materials, dyes and other products, which has been profitable to the chemical industry. The wood-distillation industry likewise has shown signs of improvement, with increased demand and higher prices. Manufacturers of acetone and of lacquer solvents have especially benefitted. The tanneries, which have experienced a particularly difficult period look upon the situation as somewhat improved following the agreement among shoe manufacturers and this increased activity has resulted in a better demand for sodium thiosulphate, bichromate, tanning chemicals, and dyes.

On the other hand, the situation in the metallurgical field remains difficult and manifests itself in decreased earnings and reduced dividends. Thus a company as strong as La Marine et Homècourt has seen profits drop from 32,000,000 fr. in 1930 to 11,000,000 fr. in 1931; for the last period a net profit of only 3,000,000 fr. is predicted. This condition necessarily affects the coal industry, and the coal producers have been forced to reduce production. Cie de Bèthune, which operates important chemical factories in connection with its distillation plants, has reduced the tonnage of coal mined by 20 per cent and the coke output by 40 per cent, with a corresponding decrease in the tonnage of byproducts.

To summarize, the chemical industry may be said to have suffered comparatively less than textile manufacturers and the metallurgical industry, at least as far as production is concerned, the drop in which is only 25 to 30 per cent of normal. Predictions of economic results for the current year are difficult.

NAMES IN THE NEWS

H. L. PARR, well known to the industry in his former capacity as manager of the Standard Calorimeter Co., and other associates of the late Prof. S. W. Parr have acquired the scientific instrument business of the Burgess-Parr Co. and have organized the Parr Instrument Co. with headquarters at Moline, Ill.

G. ST. J. PERROTT is now located at New York City engaged in consulting work in connection with the safe handling, transportation, and use of explosives and of gaseous and liquid fuels. Formerly he was superintendent of the Pittsburgh Experimental Station, U. S. Bureau of Mines.

FRANK E. LAYMAN, formerly manager of the molded insulation department of the Cutler-Hammer Manufacturing Co., has become associated with the Sherka Chemical Co.

ROBERT B. HARPER, vice-president in charge of research and testing of the Peoples Gas Light and Coke Co., Chicago, has been awarded the Beal medal for 1932. The award was made by the executive board of the American Gas Association for Mr. Harper's paper, "Gas Flames in Conversion to New Gases," the best technical paper, covering original work on a scientific development of fundamental importance to the industry, during the year.

A. A. MACCUBBIN, formerly chief engineer of the Barrett Co., has joined the Executive Engineers, Inc., as vice-president.

M. H. MEIGHAN, until recently chemical engineer with the Lehigh Portland Cement Co., is now with the Metals Disintegrating Co., Elizabeth, N. J.

ROBERT D. LANDRUM after an absence of ten years has returned to the Harshaw Chemical Co. He is in charge of the Chicago office of the company. In the interim he has been associated with the Vitreous Enameling Co. and the Titanium Alloy Manufacturing Co.

D. C. JACKLING has been awarded the John Fritz medal for notable industrial achievements in initiating mass production of copper from low grade ores, through application of engineering principles. The award was made by representatives of the national societies of civil, mining and metallurgical, mechanical, and electrical engineers.

H. L. Parr

J. KAYE WOOD, in the past several times a contributor to *Chem. & Met.* on subjects of corrosion and the high temperature-high pressure behavior of metals, has recently been appointed vice-president of the newly formed General Spring Co., New York City. He will continue his practice as consultant in mechanical and structural engineering.

W. H. DRAPER, plant superintendent of the gas department, British Columbia Electric Railway Co., Vancouver, has been promoted to superintendent of the gas division of this company for Vancouver Island.

JOHN T. STEARN, who during the past two years, has been in charge of the production department of Toledo Synthetic Products, Inc., has rejoined the investigatory staff of Mellon Institute of Industrial Research, where he will head the industrial fellowship sustained by his company. A. M. Howald, former holder of the same fellowship, is now engaged in production research in the company's plant in Toledo, Ohio.

CHARLES F. MASON, formerly director of the Doctors' Laboratory, New York City, has joined the staff of the Stillwell Laboratories of the same city as an associate consultant and director of research.

E. T. OAKES has been appointed chief chemist of the laboratory division of the National Biscuit Co.

CALENDAR

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, annual meeting, Washington, D. C., Dec. 7-9.

COMPRESSED GAS MANUFACTURERS ASSOCIATION, annual meeting, New York, Jan. 23-24.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY, annual meeting, New York, Feb. 13-16.

AMERICAN CHEMICAL SOCIETY, 85th meeting, Washington, D. C., March 26-April 1.

ELECTROCHEMICAL SOCIETY, spring meeting, Montreal, May 11-13.

AMERICAN SOCIETY FOR TESTING MATERIALS, Chicago, Ill., June 26-30, 1933.

FOURTEENTH EXPOSITION OF CHEMICAL INDUSTRIES, New York, week of Dec. 4-9, 1933.

OBITUARY

JOHN H. STEVENS, former general manager of the Celluloid Corp., died Dec. 5 at his home in South Orange, N. J., after an illness of more than a year. He was 80 years old. Mr. Stevens was an assistant to John W. Hyatt when the latter developed the process for the manufacture of celluloid. He was first employed by the Albany Dental Plate Co., one of the first producers of celluloid. This company later merged with the Celluloid Manufacturing Co. In 1890 he became manager of the production department of the company, and subsequently he supervised the entire business as general manager, retiring as such five years ago.

John H. Stevens

Changes in Acid Manufacture Cut Down Salt Cake and Niter Cake Supply

CENSUS figures for 1931 report a material falling off in domestic production of hydrochloric and nitric acids in comparison with the totals produced in 1929. In each case, the smaller output reflects the position of the different consuming industries. On the same authority production of salt cake in 1931 was 121,366 tons compared with 206,612 tons in 1929 and niter cake totals were 34,908 tons and 111,522 tons for 1931 and 1929 respectively.

The fact that the salt cake supply for the two-year period declined to a greater degree than hydrochloric acid supply calls attention to the effects which followed the change in process for manufacturing the acid. This is exemplified still more strikingly in the case of nitric acid and niter cake. Production of nitric acid in 1931 was less than 19 per cent below that reported for 1929. In contrast, production of niter cake for the same interval was reduced close to 69 per cent. In fact the statistics for niter cake bear out the report that, with one exception, nitric acid manufacturers are employing the ammonia-oxidation process.

The curtailment of salt cake production as a byproduct of hydrochloric acid manufacture gave some stimulus to the development of natural deposits in recent years. Production of sodium sulphates from natural deposits in 1931 were reported at 32,510 tons compared with 32,630 tons in 1930. These totals include glaubers salt as well as salt cake.

Production of natural sodium sulphate in the United States in recent years was as follows:

	Short Tons	Value
1931	32,510	$198,132
1930	32,630	203,348
1929	7,540	41,199
1928	6,580	42,485
1927	23,080	168,882
1926	19,620	166,800
1925	9,940	84,380

Imports of salt cake increased very appreciably in recent years with import data as follows:

	Lb.	Value
1931	151,061,330	$860,738
1930	173,329,114	892,154
1929	125,181,318	549,736
1928	37,239,231	164,551
1927	16,207,970	76,222

The largest production of natural salt cake in 1931 was from the deposit owned by the Sodium Products Corp., leased and operated by the Arizona Chemical Co. The plant is located at Camp Verde, Ariz. The Rhodes Alkali & Chemical Corp. also produced a small quantity from deposits near Mina, Nev.

Recent reports from Monahans, Texas, state that the sodium impregnated waters of Soda Lake, situated 14 miles south of here, are to be commercialized on an extensive scale by the Ozark Chemical Co. of Tulsa, Okla., which has let the contract for the construction of a plant to cost $350,000 for the extraction of sodium sulphate from the lake. The company has been making tests and experiments during the last several months to determine the best method of handling the water. It was found that the sodium sulphate can be precipitated in practically its pure state by the freezing process.

New Production Planned

Further efforts to increase domestic production of natural salt cake are found in an announcement of last month to the effect that the Salt Lake Sodium Products Company is preparing to erect a refining plant for the production of sulphate of soda and its derivatives from raw material obtained from the southeast shore of Great Salt Lake, near Saltair, Utah. The company is operating under a sublease from the Great Salt Lake Chemical Co. of Salt Lake City.

The large outlet for salt cake and niter cake in Canada formerly made large exports to that country possible but more recently the trend has been toward a greater home production in Canada and a cutting down of the amounts imported. In addition to the large market for salt cake in the pulp and paper industry a large tonnage is converted into niter cake and used in the Oxford process for the separation of the mixed sulphides of copper and nickel in the matte from the ore at the Copper Cliff Mines.

Imports of salt cake have cut so deeply into the domestic trade that over a year ago a request for an anti-dumping order was requested by producers in this country. The application was strongly opposed by Kraft paper, textile, and glass interests and it was decided that a decision of dumping was not justified .

The hearings, however, which developed as a result of the dumping charge brought out considerable information about the domestic salt cake industry and among other things revealed that domestic output of natural cake could not compete in price with the imported material.

German exports of sulphate of soda and niter cake in the first half of this year totaled 47,558 metric tons. Shipments to the chief markets were in metric tons, as follows: United States, 16,789; Belgium, 7,702; Sweden, 6,772; Finland, 3,183; the Netherlands, 2,111; Panama, 1,359; Czecho-Slovakia, 1,848; and Italy, 1,300.

Production of Hydrochloric and Nitric Acids, Salt Cake, and Niter Cake, Census Years, 1923-1931

	1931	1929	1927	1925	1923
Hydrochloric Acid					
Total production, tons	172,672	257,857	224,596	227,800	218,521
Made and consumed in same establishments, tons	44,122	61,379	62,154	72,781	62,707
For sale, tons	128,550	196,478	162,442	155,019	155,814
Value	$2,422,439	$3,195,415	$3,016,014	$2,976,155	$3,102,172
Nitric Acid, basis 100 per cent					
Total production, tons	116,275	143,454	121,991	119,652	113,116
Made and consumed, tons	84,889	110,493	93,285	92,800	91,357
For sale, tons	31,386	32,961	28,706	26,852	21,759
Value	$3,349,099	$3,494,577	$3,559,436	$3,559,695	$2,741,370
Salt Cake					
Total production, tons	121,366	206,612	208,565	189,293	187,064
Made and consumed, tons	20,672	36,436	33,573	48,450	46,047
For sale, tons	100,694	170,176	174,992	140,843	141,017
Value	$1,571,451	$2,014,838	$2,786,818	$2,339,002	$2,972,013
Niter Cake					
Total production, tons	34,908	111,522	153,615	124,296	154,087
Made and consumed, tons	5,019	28,839	33,109	22,700	24,640
For sale, tons	29,889	82,683	120,506	101,596	129,447
Value	$543,231	$1,023,136	$625,049	$400,598	$587,897

Lime Sold by Producers in the United States, 1930 and 1931, by Uses

Use	1930 Short Tons	1930 Value	1931 Short Tons	1931 Value
Agricultural	343,111	$2,372,779	297,312	$1,924,149
Building	1,204,614	10,050,270	947,085	6,940,250
Chemical:				
Glass works	62,912	408,429	59,148	345,780
Metallurgy	415,692	2,371,222	290,352	1,714,368
Paper mills	378,721	2,652,232	286,745	1,781,793
Refractory lime (dead-burned dolomite)	351,740	3,045,082	243,769	1,866,971
Sugar refineries	18,905	238,788	18,185	211,625
Tanneries	56,526	438,869	54,604	372,321
Other uses	555,659	4,038,815	510,414	3,517,656
Total chemical	1,840,155	$13,193,437	1,463,217	$9,810,514
	3,387,880	$25,616,486	2,707,614	$18,674,913
Hydrated lime (included in above totals)	1,329,562	10,357,445	1,119,266	7,729,047

CHEMICAL ECONOMICS

Production of chemicals maintained fairly steady rate throughout last month with some plants exceeding the output of the preceding month. Some consuming branches took on larger supplies of raw materials which offset slower demand in other directions

MANUFACTURING operations within the chemical industry in November proceeded at about the same rate as in the preceding month. In some cases seasonal influences were in favor of enlarged operations and in other cases the reverse was true but in general the average was about on a par with that for October. The reduction in the number of working days favored a smaller output of products and an unadjusted index therefore reports a decline in production for the period. According to data for power consumption of electrical energy the index for production of chemicals in November was 118.6 in comparison with 119.8 for October. Reports from southern sections of the country were favorable and in some cases indicated a higher productive rate than that reported for the entire country.

In the silk branch of the textile industry there has been a falling off in operations in the last two months. Deliveries of silk to mills amounted to 43,955 bales in November which compares with 53,703 bales in October and 50,645 bales in November last year.

Consumption of crude rubber by manufacturers in the United States for October amounted to 21,018 long tons. This compares with 22,491 long tons for September and represents a decrease of 6.5 per cent.

According to reports compiled by the National Fertilizer Association, October tag sales in the sixteen tag sale states were slightly larger than those for October last year. For the three months, August, September and October combined, the sales in the 13 Southern States were four per cent larger than the sales for the same three months of 1931 and were only 18 per cent smaller than the sales for August-October of 1930. Ordinarily, about six per cent of the year's annual sales are made in these three months.

Data for productive activities in some of the chemical producing and chemical consuming industries are given below for October with comparisons for the preceding month:

Production	1932 Oct.	1932 Sept.
Acetate of lime, 1,000 lb.	2,616	1,563
Arsenic, crude, ton	742	1,992
Arsenic, refined, ton	772	720
Automobiles, no.	48,934	84,141
Byproduct coke, 1,000 ton	1,739	1,544
Cotton consumed, 1,000 bales	502	492
Explosives, 1,000 lb.	22,996	19,938
Glass containers, 1,000 gr.	1,750	1,462
Plate glass, 1,000 sq.ft.	3,935	3,406
Methanol, crude gal.	249,142	98,108
Methanol, refined, gal.	197,534	102,448
Methanol, synthetic, gal.	571,372	697,890
Petroleum refined, 1,000 bbl.	66,698	63,913
Rosin, wood, bbl.	33,132	31,155
Turpentine, wood, bbl.	5,202	5,020
Pine oil, gal.	195,248	231,115
Tires, pneumatic, 1,000	2,034	2,031

Production figures for October show an encouraging advance in the output of wood distillation chemicals. Crude methanol was produced to the extent of 249,142 gal. which is a gain of more than 150 per cent over the September figure and a gain of more than 35 per cent over the total for October, last year. Refined methanol likewise was produced in larger volume in October and acetate of lime not only was greatly increased in output but shipments from producing points were larger than the amounts produced and stocks on hand were subject to further reduction.

Foreign Trade in Chemicals

Export trade in chemicals continues to fall behind the records of last year when judged on a basis of valuation but the comparison likewise is unfavorable in most cases where quantities are specified. Latest available figures for chemicals and related products refer to October returns. Shipments of coal-tar products in that month carried a higher valuation than those for the corresponding month of 1931. The increase was due largely to exports of crude coal-tar and coal-tar pitch both of which far outstripped the figures of last year.

Export trade in industrial chemical held very close to the total for October 1931 and if allowance is made for price changes, probably exceeded the 1931 figure for tonnage moved. A sharp rise featured export trade in butanol and ethylene compounds. Noteworthy increases also were reported for boric acid, copper sulphate, and carbon black.

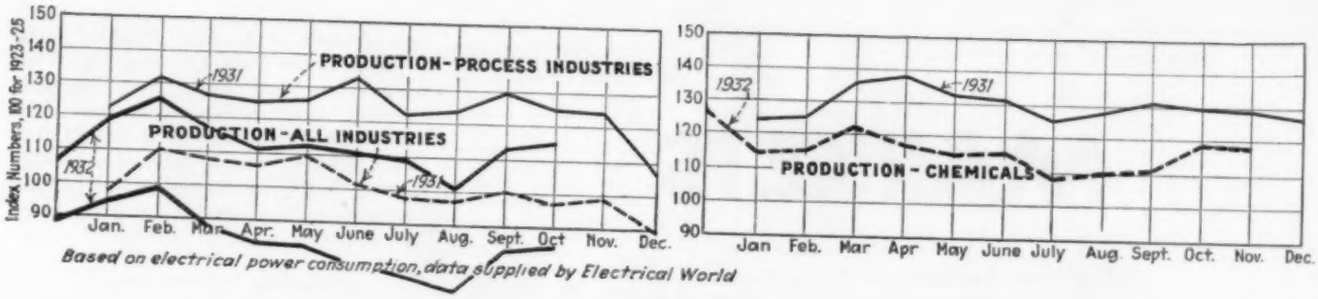
Import trade followed the general trend and October totals make a poor showing in comparison with those for October, 1931. Highlights include very much larger arrivals of acetic acid, salt cake, and ammonium sulphate. Ammonium chloride, ammonium nitrate, and calcium compounds also surpassed the figures for 1931. On the other hand incoming amounts of nitrate of soda reached a total of but 13 tons and a decided drop also was noted in the case of potassium chlorate.

Materials Used in Canadian Heavy Chemical Industry

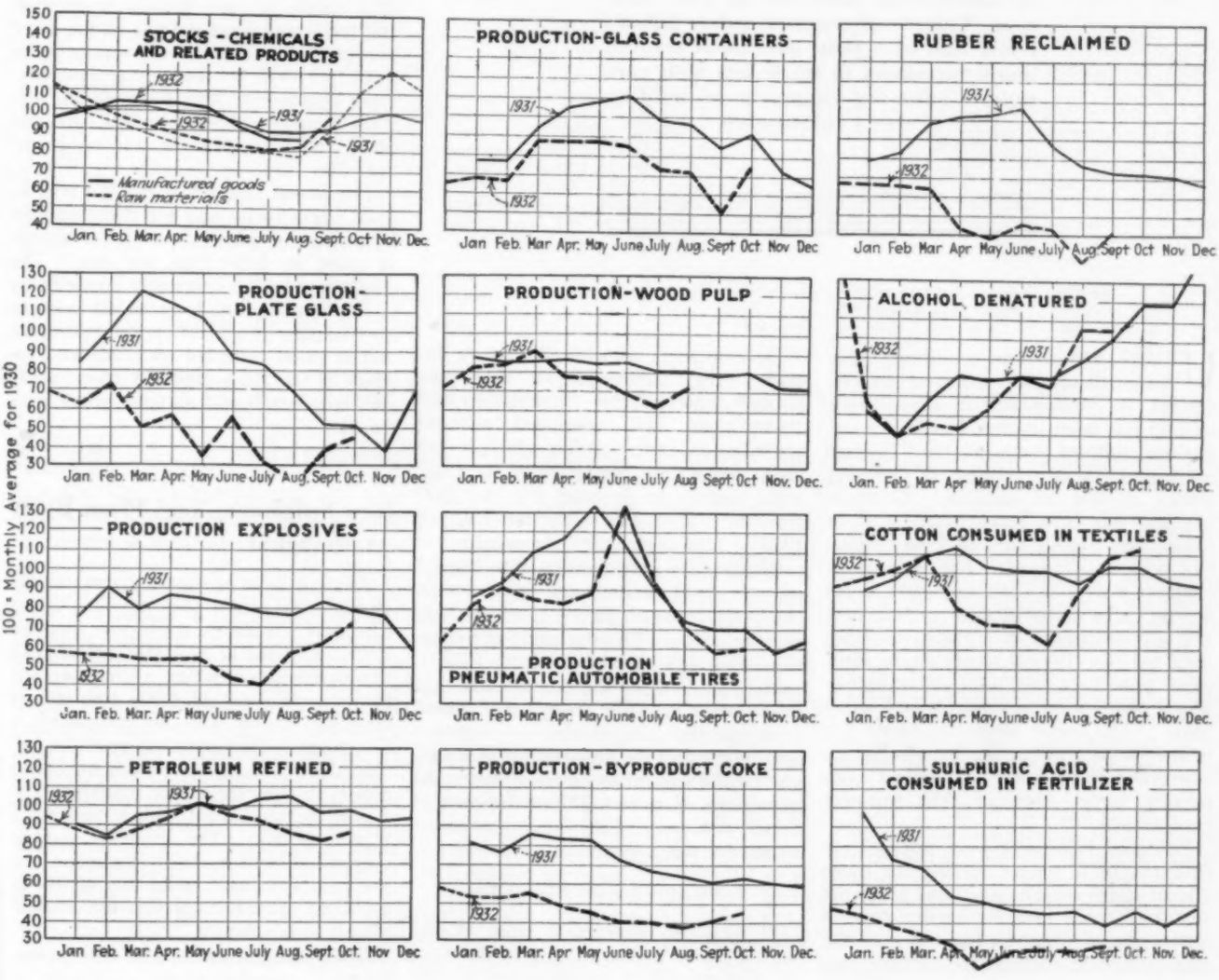
According to the Bureau of Statistics of Canada cost of chemicals and related raw materials used in manufacturing acids, alkalis and salts amounted to $2,407,682 in 1931 and $4,712,471 in 1930.

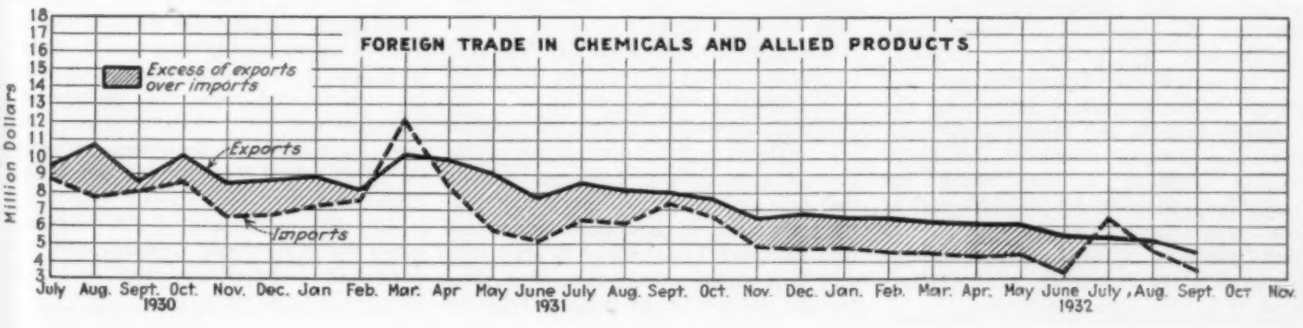
The quantities of these materials used in this industry for these two years are shown below:

Materials	Unit of Measure	1930 Quantity	1931 Quantity
Aluminum sulphate	lb.	125,829	121,712
Ammonia liquor	lb. NH_3	159,166	152,982
Ammonia, anhydrous	lb.	27,444	25,367
Calcium carbonate	ton	369,173	163,273
Calcium chloride	lb.	216,588	.....
Calcium fluoride	ton	3,081	934
Coke (not for fuel)	ton	108,220	39,904
Coal (not for fuel)	ton	20,440	18,669
Electrodes	ton	3,026	1,276
Iron sulphide	ton	8,241	8,908
Silica	ton	5,345	6,012
Sodium carbonate	ton	320	262
Sodium chloride, dry	ton	9,739	9,408
Sodium chloride, brine	ton	114,302	97,502
Sodium hydroxide	lb.	344,225	211
Sodium nitrate	ton	1,097	1,022
Sodium silicate	lb.	17,189	.....
Sodium sulphate	ton	10,867	15,602
Sulphur	ton	20,277	15,308
Sulphuric acid, 66°BE	ton	1,976	1,602


Index Numbers, 100 for 1923-25
PRODUCTION-PROCESS INDUSTRIES
PRODUCTION-ALL INDUSTRIES
1931
1932
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct Nov. Dec.
Based on electrical power consumption, data supplied by Electrical World
PRODUCTION-CHEMICALS
Jan Feb. Mar Apr May June July Aug. Sept. Oct. Nov. Dec.

TRENDS OF PRODUCTION AND CONSUMPTION




FOREIGN TRADE IN CHEMICALS AND ALLIED PRODUCTS
Million Dollars
Excess of exports over imports
Exports
Imports
July Aug. Sept. Oct. Nov. Dec. Jan Feb. Mar. Apr May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct Nov.
1930
1931
1932

MARKETS

Contract business enlivens trading in heavy chemicals. Producers offer alkalis, bichromates, solvents, and other products for delivery over next year. Prices in general are about the same as those which prevailed on 1932 business. Volume of contract orders fails to reach that of a year ago. Spot trading mainly confined to small lots with consumers adhering to policy of holding down inventories

USUAL end-of-year conditions have made themselves manifest in the market for chemicals of late. Spot trading has been light and ordering out against contract commitments has been influenced by the policy of holding stocks as low as possible. Contract business has been more active and in some cases a good part of 1933 outputs has been sold ahead. The volume of contract orders to date, however, is reported to be below that of a year ago. The announcement of higher prices for soda ash for 1933 delivery came after some producers had been soliciting renewal orders on an unchanged price basis. The same situation exists for caustic soda and as far as alkalis are concerned the market is nominal with private terms entering into business transactions.

Seasonal influences were not entirely in favor of a slower market for more encouraging reports emanated from the fertilizer trade and the higher rate of automotive production has aided in the distribution of plating and lacquer materials. Colder weather in different sections of the country has quickened demand for anti-freeze preparations. Incidentally the production program of the automobile companies for this month indicates greater activity by the industry than in any month since June. Based on proposed schedules, this month should establish a high mark for monthly production for the last half of the current year, exceeding the 118,613 units produced in July and probably also surpassing the December, 1931, production of 123,965 cars and trucks.

Developments of a tariff nature included the announcement that the United States Tariff Commission has discontinued and dismissed without prejudice an investigation which it has been conducting since June 9, 1931, with respect to flaxseed for the purposes of section 336 of the tariff act of 1930. However, the commission is continuing its investigation into linseed oil and combinations and mixtures in the chief value of such oil, which later was included in the provisions of Senate resolution 243 adopted June 20, 1932.

It is planned by the commission that the information with respect to flaxseed collected thus far in the investigation will be used in the preparation of a survey on the subject to be made under the provisions of section 332 of the present tariff law, according to a statement issued by the commission.

Tariff Hearing on Plate Glass

It was also announced from Washington that a public hearing in the Tariff Commission's investigation of the present rate of duty on plate glass has been set for February 1. The investigation instituted under the flexible tariff provisions covers plate glass, by whatever process made.

While domestic supplies of sulphur are ample enough to provide for wants over a long period, it is now certain that new production will get under way in Louisiana. It has been announced that Freeport Texas Co. will start construction in the near future of a plant for the production of sulphur from its new deposit at Grande Ecaille, about 50 miles below New Orleans, La. This deposit has been leased from the Gulf Refining Co. of Louisiana, the Shell Petroleum Corp. and the Humble Oil & Refining Co. on a favorable profit-sharing basis, profits to be determined by the cost of production and the price of sulphur.

Sicilian Sulphur Tax

In Sicily prior to the dissolution of the consortium, a basic lump sum tax was levied on all sulphur sold. The decree now provides for the same method of a single tax for private production and trade and fixes the tax at the same percentage basis of the average sales price per ton, as heretofore, namely: 1 per cent on the first 300 Lire per ton. 2 per cent on prices over 300 Lire and up to 700 Lire. 10 per cent on prices over 700 Lire.

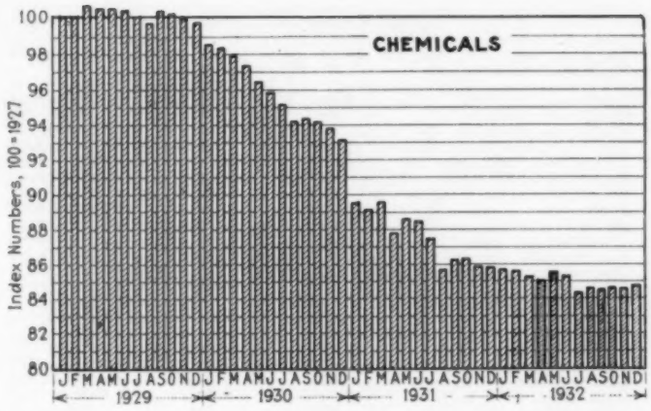
The actual amount of the tax will be fixed periodically and for three months following the publication of the decree, is fixed at 3.50 Lire per ton. The single tax, which originally applied only to Sicilian sulphur, is extended to cover also sulphur produced on the mainland, and is to be collected on crude and refined at the time exported from Sicily and on Continental sulphur when produced.

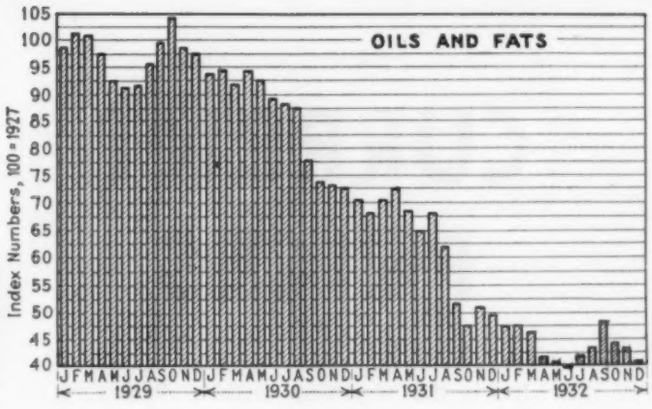
New Sulphuric Acid Plant Built At Shanghai

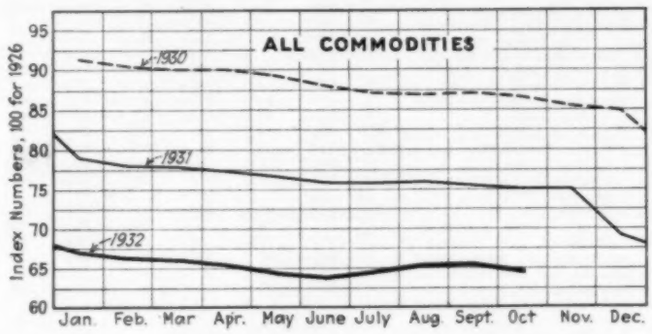
Advices from our trade commissioner at Shanghai states that the Kai Cheng Chemical Company, a Chinese corporation capitalized at $750,000 (Mexican), has under construction a chamber sulphuric acid plant of 6,000 tons annual capacity which will be completed in December. This company recently purchased machinery for a nitric acid plant and is in the market for machinery for a muriatic acid plant with a capacity of 8 tons a day. The company has acquired sufficient land for expansion near the sulphuric acid plant for additional chemical operations which are contemplated in the future.

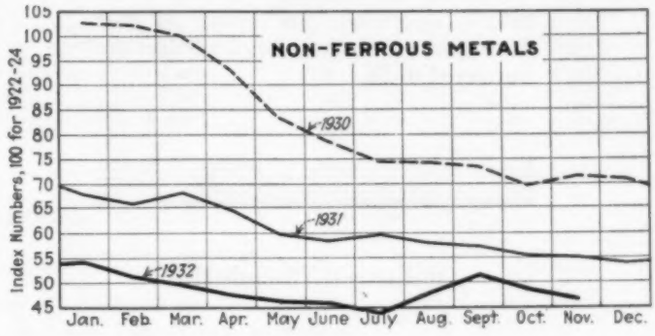
This company is the first with private Chinese capital to produce acids for industrial uses. One British plant of 1,000 tons capacity has been in operation in Shanghai for some years. Other acid plants are in operation, but these are controlled by the government arsenals and have been used only for the manufacture of munitions. Imports of acids into China total about 10,000 tons per annum.

For the production of the sulphuric acid, the Kai Cheng company will use imported sulphur, pyrites or other sulphur-bearing ores.









PRICE TRENDS—CHEM. & MET.'S WEIGHTED INDEXES

CHEMICALS in common with many other commodities showed an irregular price trend during the past month. A slight advance in quotations for nitrate of soda went into effect automatically at the beginning of the month. The openly quoted contract prices for soda ash indicated an advance of one dollar a ton over the former contract quotations. Furthermore attempts were made to observe this differential on actual contract orders but buyers as a rule were able to duplicate last years figures. Bichromates were quoted at reduced levels and producers have taken the initiative in trying to sign up large consuming interests. Phosphate of soda has been under keen selling pressure and low prices have prevailed on all business put through in the last two months. Tartaric acid and cream of tartar have maintained a consistent downward price trend and made new lows during the week.

The chemical market as a whole appears to have reached bottom as far as price levels are concerned but a quiet buying period brings out pressure from sellers and the desire to book orders for future delivery or to reduce spot stocks prevents any real price stability and practically makes price steadiness dependent on an upturn in buying activities. Over the remainder of the year but little change can be looked for. Consumers will not care to increase inventories and with buying restricted to actual needs the spot market probably will present soft spots.

The manner in which chemical prices have been adjusted is exemplified by the fact that while consuming demand for most products this year fell considerably below the standard of last year, and while this encouraged a continued downward price trend, the price movement was orderly and moderate. In January the weighted index number stood at 85.77 and the December index number is 84.81. This relatively slight recession over a 12-months period offers striking evidence that values are so low that only sub-normal trading activities will hold them down to the existing figures.

Vegetable oils fail to show any tendency toward price recovery. Sharp downward revision was reported for the index number this month and practically everything listed in the vegetable oil and animal fats market contributed to the downward movement. Linseed oil which, from a statistical standpoint, might be expected to sell at higher prices, moved in sympathy with the general market aided by a lack of sustained buying interest on the part of the large consuming industries. Crude Menhaden oil was offered at record low prices in the far south and quotations at other points were entirely nominal with no stocks changing hands.

Animal fats were reported to be in a more favorable position at the end of the period. This was based on belief that grains were due to appreciate in value and that fats would follow suit.

Chem. & Met. Weighted Index of Chemical Prices

Base = 100 for 1927

This month	**84.81**
Last month	84.61
December, 1931	85.94
December, 1930	93.17

A firmer market for chlorine and higher quotations for soda ash had a strengthening effect on the index number although ash price was by no means a basis of trading. Declines in chemicals were more frequent than advances but affected the weighted position to a lesser degree.

Chem. & Met. Weighted Index of Prices for Oils and Fats

Base = 100 for 1927

This month	**40.27**
Last month	43.15
December, 1931	49.40
December, 1930	72.69

Price reductions were again fairly general throughout the market for vegetable oils and fats. Lack of buying interest caused values to sag with large supplies of most selections adding to the weak side of the market.

CURRENT PRICES

The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to Dec. 9.

Industrial Chemicals

	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.10 -$0.11	$0.10 -$0.11	$0.10 -$0.11
Acid, acetic, 28%, bbl., cwt.	2.65 - 2.90	2.65 - 2.90	2.50 - 2.75
Glacial 99%, tanks	8.89	8.89 -	8.10 -
drs.	9.14 - 9.39	9.14 - 9.39	8.35 - 8.60
U. S. P. reagent, c'bys.	9.64 - 9.89	9.64 - 9.89	8.85 - 9.10
Boric, bbl., lb.	.04½- .05	.04½- .05	.06½- .07
Citric, kegs, lb.	.29 - .31	.29 - .31	.35 - .36
Formic, bbl., lb.	.10 - .11	.10 - .11	.10 - .11
Gallic, tech., bbl., lb.	.50 - .55	.50 - .55	.50 - .55
Hydrofluoric 30% carb., lb.	.06 - .07	.06 - .07	.06 - .07
Latic, 44%, tech., light, bbl., lb.	.11½- .12	.11½- .12	.11½- .12
22%, tech., light, bbl., lb.	.05½- .06	.05½- .06	.05½- .06
Muriatic, 18° tanks, cwt.	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Nitric, 36°, carboys, lb.	.05 - .05¼	.05 - .05¼	.05 - .05¼
Oleum, tanks, wks., ton.	18.50 -20.00	18.50 -	18.50 -20.00
Oxalic, crystals, bbl., lb.	.11 - .11½	.11 - .11½	.11 - .12
Phosphoric, tech., c'bys., lb.	.08½- .09	.08½- .09	.08½- .09
Sulphuric, 60°, tanks, ton.	11.00 -11.50	11.00 -11.50	11.00 -11.50
Sulphuric, 66°, tanks, ton.	15.50 -	15.50 -	15.50 -
Tannic, tech., bbl., lb.	.23 - .35	.23 - .35	.23 - .35
Tartaric, powd., bbl., lb.	.20 - .21	.22 - .22½	.26½- .27½
Tungstic, bbl., lb.	1.40 - 1.50	1.40 - 1.50	1.40 - 1.50
Alcohol, ethyl, 190 p'f., bbl., gal.	2.53½-	2.53½-	2.33 -
Alcohol, Butyl, tanks, lb.	.113 -	.113 -	.143 -
Alcohol, Amyl	-	-	-
From Pentane, tanks, lb.	.182-	.182-	.203 -
Denatured, 190 proof			
No. 1 special dr., gal.	.34½-	.34½-	.28 -
No. 5, 188 proof, dr., gal.	.38½-	.38½-	.28 -
Alum, ammonia, lump, bbl., lb.	.03 - .04	.03 - .04	.03½- .04
Chrome, bbl., lb.	.04½- .05	.04½- .05	.04½- .05
Potash, lump, bbl., lb.	.03 - .04	.03 - .04	.03½- .04
Aluminum sulphate, com., bags, cwt.	1.25 - 1.40	1.25 - 1.40	1.25 - 1.40
Iron free, bg., cwt.	1.90 - 2.00	1.90 - 2.00	1.90 - 2.00
Aqua ammonia, 26°, drums lb.	.02½- .03	.02½- .03	.02½- .03
tanks, lb.	.02½- .02¾	.02½- .02¾	.02½- .02¾
Ammonia, anhydrous, cyl., lb.	.15½- .15¾	.15½- .15¾	.15½- .15¾
tanks, lb.	.05 -	.05 -	.05½-
Ammonium carbonate, powd. tech., casks, lb.	.10 - .11	.10 - .11	.10½- .11
Sulphate, wks., cwt.	1.025-	1.025-	1.10 -
Amylacetate tech., tanks, lb., gal.	.16 -	.16 -	.16½
Antimony Oxide, bbl., lb.	.07 - .08	.07 - .08	.08 - .09
Arsenic, white, powd., bbl., lb.	.04 - .04¼	.04 - .04¼	.04 - .04¼
Red, powd., kegs, lb.	.09 - .10	.09 - .10	.09 - .10
Barium carbonate, bbl., ton.	56.50 -58.00	56.50 -58.00	56.50 -58.00
Chloride, bbl., ton	63.00 -65.00	63.00 -65.00	63.00 -65.00
Nitrate, cask, lb.	.07½- .07¾	.07½- .07¾	.07 - .07¼
Blanc fixe, dry, bbl., lb.	.03½- .04	.03½- .04	.03½- .04
Bleaching powder, f.o.b., wks., drums, cwt.	1.75 - 2.00	1.75 - 2.00	2.00 - 2.10
Borax, grain, bags, ton.	40.00 -45.00	40.00 -45.00	50.00 -57.00
Bromine, cs., lb.	.36 - .38	.36 - .38	.36 - .38
Calcium acetate, bags	2.50 -	2.50 -	2.00 -
Arsenate, dr., lb.	.05½- .06½	.05½- .06½	.06 - .07
Carbide drums, lb.	.05 - .06	.05 - .06	.05 - .06
Chloride, fused, dr., wks., ton.	18.00 -	18.00 -	20.00 -
flake, dr., wks., ton.	21.00 -	21.00 -	22.75 -
Phosphate, bbl., lb	.07½- .08	.07½- .08	.08 - .08½
Carbon bisulphide, drums, lb.	.05 - .06	.05 - .06	.05 - .06
Tetrachloride drums, lb.	.06½- .07	.06½- .07	.06½- .07
Chlorine, liquid, tanks, wks., lb.	.0165 -	.0155-	.01½-
Cylinders	.05½- .06	.05½- .06	.04 - .06
Cobalt oxide, cans, lb.	1.25 - 1.35	1.25 - 1.35	1.35 - 1.45
Copperas, bgs., f.o.b. wks., ton.	13.00 -14.00	13.00 -14.00	13.00 -14.00
Copper carbonate, bbl., lb.	.07 - .16	.07 - .16	.07 - .16
Cyanide, tech., bbl., lb.	.39 - .44	.39 - .44	.39 - .44
Sulphate, bbl., cwt.	3.00 - 3.25	3.00 - 3.25	3.10 - 3.25
Cream of tartar, bbl., lb.	.16 - .16½	.16½- .17	.20½- .22
Diethylene glycol, dr., lb.	.14 - .16	.14 - .16	.14 - .16
Epsom salt, dom., tech., bbl., cwt.	1.70 - 2.00	1.70 - 2.00	1.70 - 2.00
Imp., tech., bags, cwt.	1.15 - 1.25	1.15 - 1.25	1.15 - 1.25
Ethyl acetate, drums, lb.	.09½-	.10 -	.06½-
Formaldehyde, 40%, bbl., lb.	.06 - .07	.06 - .07	.06 - .07
Furfural, dr., contract, lb.	.10 - .17½	.10 - .17½	.10 - .17½
Fusel oil, crude, drums, gal.	1.10 - 1.20	1.10 - 1.20	1.10 - 1.20
Refined, dr., gal.	1.80 - 1.90	1.80 - 1.90	1.80 - 1.90
Glaubers salt, bags, cwt.	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Glycerine, c.p., drums, extra, lb.	.10½- .10¾	.10½- .10¾	.11½- .12
Lead:			
White, basic carbonate, dry casks, lb.	.06½-	.06½-	.07½-
White, basic sulphate, sck., lb.	.06 -	.06 -	.07 -
Red, dry, sck., lb.	.06½-	.06½-	.07½-
Lead acetate, white crys., bbl., lb.	.10 - .11	.10 - .11	.10 - .11
Lead arsenate, powd., bbl., lb.	.09½- .14	.09½- .14	.10 - .14
Lime, chem., bulk, ton.	8.50 -	8.50 -	8.50 -
Litharge, pwd., csk, lb.	.05½-	.05½-	.06½-
Lithophone, bags, lb.	.04½- .05	.04½- .05	.04½ .05
Magnesium carb., tech., bags, lb.	.05½- .06	.05½- .06	.06 - .06½
Methanol, 95%, tanks, gal.	.33	.33 -	.33 -
97%, tanks, gal.	.34	.34 -	.34 -
Synthetic, tanks, gal.	.35½-	.35½-	.35½-
Nickel salt, double, bbl., lb.	.11 - .11½	.10½- .11	.10½- .11
Orange mineral, csk., lb.	.09½-	.09½-	.09½-
Phosphorus, red, cases, lb.	.42 - .44	.42 - .44	.42 - .44
Yellow, cases, lb.	.28 - .32	.28 - .32	.31 - .32
Potassium bichromate, casks, lb.	.07½- .08	.08 - .08½	.08½- .09
Carbonate, 80-85%, calc. csk., lb	.05 - .05½	.05 - .05½	.05½- .06
Chlorate, powd., lb.	.08 - .08½	.08 - .08½	.08 - .08½
Hydroxide (c'stic potash) dr., lb.	.06½- .06¾	.06½- .06¾	.06½- .06¾
Muriate, 80% bgs., ton.	37.15 -	37.15 -	37.15 -
Nitrate, bbl., lb.	.05½- .06	.05½- .06	.05½- .06
Permanganate, drums, lb.	.16 - .16½	.16 - .16½	.16 - .16½
Prussiate, yellow, casks, lb.	.18½- .19½	.18½- .19	.18½- .19
Sal ammoniac, white, casks, lb.	.04½- .05	.04½- .05	.04½- .05
Salsoda, bbl., cwt.	.90 - .95	.90 - .95	.90 - .95
Salt cake, bulk, ton.	13.00 -15.00	13.00 -15.00	16.00 -18.00
Soda ash, light, 58%, bags, contract, cwt.	1.20 -	1.15 -	1.15 -
Dense, bags, cwt.	1.22½-	1.17½-	1.17½-
Soda, caustic, 76%, solid, drums, contract, cwt.	2.50 - 2.75	2.50 - 2.75	2.50 - 2.75
Acetate, works, bbl., lb.	.05 - .06	.05 - .06	.05 - .05½
Bicarbonate, bbl., cwt.	1.85 - 2.00	1.85 - 2.00	1.85 - 2.00
Bichromate, casks, lb.	.04½- .05	.05 - .06	.06 - .07
Bisulphate, bulk, ton.	14.00 -16.00	14.00 -16.00	14.00 -16.00
Bisulphite, bbl., lb.	.03½- .04	.03½- .04	.03½- .04
Chlorate, kegs, lb.	.05½- .07½	.05½- .07½	.05½- .07½
Chloride, tech., ton.	12.00 -14.75	12.00 -14.75	12.00 -14.00
Cyanide, cases, dom., lb.	.15½- .16	.15½- .16	.16½- .17
Fluoride, bbl., lb.	.07½- .08	.07½- .08	.07½- .08
Hyposulphite, bbl., lb.	2.40 - 2.50	2.40 - 2.50	2.40 - 2.50
Metasilicate, bbl., cwt.	3.60 - 3.75	3.60 - 3.75	3.60 - 3.75
Nitrate, bags, cwt.	1.295-	1.27 -	1.77 -
Nitrite, casks, lb	.07½- .08	.07½- .08	.07½- .08
Phosphate, dibasic, bbl., lb.	.018- .02	.018- .02	.0265 - .03
Prussiate, yel. drums, lb.	.11½- .12	.11½- .12	.11½- .12
Silicate (40° dr.) wks. cwt.	.70 - .75	.70 - .75	.70 - .75
Sulphide, fused, 60-62%, dr., lb.	.02½- .03½	.02½- .03	.02½- .03
Sulphite, cyrs., bbl., lb.	.03 - .03½	.03 - .03½	.03 - .03½
Sulphur, crude at mine, bulk, ton	18.00 -	18.00 -	18.00 -
Chloride, dr., lb.	.03½- .04	.03½- .04	.05 - .06
Dioxide, cyl., lb.	.06½- .07	.06½- .07	.06½- .07
Flour, bag, cwt.	1.55 - 3.00	1.55 - 3.00	1.55 - 3.00
Tin bichloride, bbl., lb.	nom.-	nom.-	nom.-
Oxide, bbl., lb.	.27½-	.27½-	.25 -
Crystals, bbl., lb.	.24 -	.24 -	.22½-
Zinc chloride, gran., bbl., lb.	.06½- .06¾	.06½- .06¾	.06½- .06¾
Carbonate, bbl., lb.	.10½- .11	.10½- .11	.10½- .11
Cyanide, dr., lb.	.38 - .42	.41 - .42	.41 - .42
Dust, bbl., lb.	.04½- .06	.04½- .05	.05½- .06
Zinc oxide, lead free, bag, lb.	.05½-	.05½-	.06½-
5% lead sulphate, bags, lb.	.05½-	.05½-	.06½-
Sulphate, bbl., cwt.	3.00 - 3.25	3.00 - 3.25	3.00 - 3.25

Oils and Fats

	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	$0.08½-$0.09	$0.09½-$0.10	$0.09½-$0.10
Chinawood oil, bbl., lb.	.05½-	.05½-	.07 -
Coconut oil, Ceylon, tanks, N. Y. lb.	.03½-	.03½-	.03½-
Corn oil crude, tanks, (f.o.b. mill), lb	.03 -	.03½-	.03½-
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.02½-	.03 -	.03½-
Linseed oil, raw car lots, bbl., lb.	.062-	.067-	.072-
Palm, Lagos, casks, lb.	.03½-	.03½-	.04 -
Niger, casks, lb.	.03½-	.03½-	.03½-
Palm Kernel, bbl., lb.	.04½-	.04½-	.05½-
Peanut oil, crude, tanks (mill), lb.	.03½-	.03½-	.04 -
Rapeseed oil, refined, bbl., gal.	.31 - .32	.33 - .34	.42 - .43
Soya bean, tank (f.o.b. Coast), lb.	nom.-	nom.-	nom.-
Sulphur (olive foots), bbl., lb.	.04½-	.04½-	.04½-
Cod, Newfoundland, bbl., gal.	.23 - .26	.21 - .26	.26 - .28
Menhaden, light pressed, bbl., gal.	.27 - .28	.27 - .28	.33 - .34
Crude, tanks (f.o.b. factory), gal.	.09½-	.09½-	.17½-
Grease, yellow, loose, lb.	.02½-	.02½-	.02½-
Oleo stearine, lb.	.04½-	.05½-	.06½-
Red oil, distilled, d.p. bbl., lb.	.06½-	.06½-	.07½-
Tallow, extra, loose, lb.	.02½-	.02½-	.03½-

Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	$0.60 –$0.65	$0.60 –$0.65	$0.60 –$0.62
Refined, bbl., lb.	.80 – .85	.80 – .85	.80 – .85
Alpha-naphthylamine, bbl., lb.	.32 – .34	.32 – .34	.32 – .34
Aniline oil, drums, extra, lb.	.14½– .15	.14½– .15	.15 – .16
Aniline salts, bbl., lb.	.24 – .25	.24 – .25	.24 – .52
Benzaldehyde, U.S.P., dr., lb.	$1.10 –$1.25	$1.10 –$1.25	$1.10 –$1.25
Benzidine base, bbl., lb.	.65 – .67	.65 – .67	.65 – .67
Benzoic acid, U.S.P., kgs, lb.	.48 – .52	.48 – .52	.48 – .52
Benzyl chloride, tech., dr., lb.	.30 – .35	.30 – .35	.30 – .35
Benzol, 90%, tanks, works, gal.	.20 – .21	.20 – .21	.20 – .21
Beta-naphthol, tech., drums, lb.	.22 – .24	.22 – .24	.22 – .24
Cresol, U. S. P., dr., lb.	.10½– .11	.10½– .11	.12½– .14
Cresylic acid, 97%, dr., wks., gal.	.49 – .52	.49 – .52	.54 – .58
Diethylaniline, dr., lb.	.55 – .58	.55 – .58	.55 – .58
Dinitrophenol, bbl., lb.	.29 – .30	.29 – .30	.29 – .30
Dinitrotoluen, bbl. lb.	.16 – .17	.16 – .17	.16 – .17
Dip oil 25% dr., gal.	.23 – .25	.23 – .25	.23 – .25
Diphenylamine, bbl., lb.	.38 – .40	.38 – .40	.38 – .40
H-acid, bbl., lb.	.65 – .70	.65 – .70	.65 – .70
Naphthalene, flake, bbl., lb.	.04½– .05	.04½– .05	.03½– .04½
Nitrobenzene, dr., lb.	.08½– .09	.08½– .09	.08½– .10
Para-nitraniline, bbl., lb.	.51 – .55	.51 – .55	.51 – .55
Para-nitrotoluine, bbl., lb.	.26 – .28	.26 – .28	.29 – .31
Phenol, U.S.P., drums, lb.	.14½– .15	.14½– .15	.14½– .15
Picric acid, bbl., lb.	.30 – .40	.30 – .40	.30 – .40
Pyridine, dr., lb.	1.50 – 1.75	1.50 – 1.80	1.50 – 1.80
R-salt, bbl., lb.	.40 – .44	.40 – .44	.40 – .44
Resorcinal, tech., kegs, lb.	.65 – .70	.65 – .70	.70 – .80
Salicylic acid, tech., bbl., lb.	.33 – .35	.33 – .35	.33 – .35
Solvent naphtha, w.w., tanks, gal.	.26 –.....	.26 –.....	.26 –.....
Tolidine, bbl., lb.	.86 – .88	.86 – .88	.86 – .88
Toluene, tanks, works, gal.	.30 –.....	.30 –.....	.30 –.....
Xylene, com., tanks, gal.	.26 –.....	.26 –.....	.26 –.....

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton.	$22.00–$25.00	$22.00–$25.00	$23.00–$25.00
Casein, tech., bbl., lb.	.06 – .10½	.06 – .10½	.07½– .14
China clay, dom., f.o.b. mine, ton	8.00 –20.00	8.00 –20.00	8.00 –20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.02½– .20	.02½– .20	.03 – .20
Prussian blue, bbl., lb.	.35 – .36	.35 – .36	.35 – .36
Ultramine blue, bbl., lb.	.06 – .32	.06 – .32	.06 – .32
Chrome green, bbl., lb.	.26 – .27	.26 – .27	.27 – .30
Carmine red, tins, lb.	3.90 – 4.50	3.90 – 4.50	5.00 – 5.40
Para toner, lb.	.75 – .80	.75 – .80	.75 – .80
Vermilion, English, bbl., lb.	1.25 – 1.50	1.25 – 1.50	1.55 – 1.60
Chrome yellow, C. P., bbl., lb.	.16 – .16½	.16 – .16½	.16½– .17
Feldspar, No. 1 (f.o.b. N.C.), ton	6.50 – 7.50	6.50 – 7.50	6.50 – 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 – .08½	.07 – .08½	.07 – .08½
Gum copal Congo, bags, lb.	.06 – .08	.06 – .08	.07 – .09
Manila, bags, lb.	.16 – .17	.16 – .17	.16 – .17
Damar, Batavia, cases, lb.	.16 – .16½	.16 – .19	.16 – .16½
Kauri No. 1 cases, lb.	.45 – .48	.45 – .48	.48 – .53
Kieselguhr (f.o.b. N.Y.), ton.	50.00 –55.00	50.00 –55.00	50.00 –55.00
Magnesite, calc, ton.	40.00 –.....	40.00 –.....	40.00 –.....
Pumice stone, lump, bbl., lb.	.05 – .07	.05 – .08	.05 – .07
Imported, casks, lb.	.03 – .40	.03 – .40	.03 – .35
Rosin, H., bbl.	3.80 –.....	3.90 –.....	4.00 –.....
Turpentine, gal.	.42 –.....	.45½–.....	.39 –.....
Shellac, orange, fine, bags, lb.	.20 – .25	.20 – .25	.38 – .40
Bleached, bonedry, bags, lb.	.18 – .19	.18 – .19	.28 – .30
T. N. bags, lb.	.09½– .10	.09½– .10	.16 – .17
Soapstone (f.o.b. Vt.), bags, ton	10.00 –12.00	10.00 –12.00	10.00 –12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00 – 8.50	8.00 – 8.50	9.50 –.....
300 mesh (f.o.b Ga.), ton.	7.50 –10.00	7.50 –10.00	7.50 –11.00
225 mesh (f.o.b. N. Y.), ton.	13.75 –.....	13.75 –.....	13.75 –.....
Wax, Bayberry, bbl., lb.	.16 – .20	.16 – .20	.16 – .20
Beeswax, ref., light, lb.	.20 – .30	.20 – .30	.25 – .27
Candelilla, bags, lb.	.12 –.....	.12 –.....	.14½–.....
Carnuba, No. 1, bags, lb.	.22 – .24	.23 – .24	.32 – .33
Paraffine, crude 105-110 m.p., lb.	.03½– .03¾	.03½– .04¼	.03½– .03¾

Price Changes During Month

Advanced	Declined
Soda ash	Tartaric acid
Chlorine	Cream of tartar
Nickel salt	Ethyl acetate
Sodium Nitrate	Sodium bichromate
	Potassium bichromate
	Vegetable oils
	Tallow
	Turpentine

Ferro-Alloys

	Current Price	Last Month	Last Year
Ferrotitanium, 15-18%, ton.	$200.00–.....	$200.00–.....	$200.00–.....
Ferromanganese, 78-82%, ton.	68.00–.....	68.00–.....	80.00–85.00
Ferrochrome, 65-70%.	.10–.....	.10–.....	.11–.....
Spiegeleisen, 19-21% ton.	25.00–.....	25.00–.....	30.00–.....
Ferrosilicon, 14-17%, ton.	31.00–.....	31.00–.....	31.00–.....
Ferrotungsten, 70-80%, lb.	1.00– 1.10	1.00– 1.10	1.00– 1.10
Ferrovanadium, 30-40%, lb.	3.05– 3.40	3.05– 3.40	3.15– 3.50

Non-Ferrous Metals

	Current Price	Last Month	Last Year
Copper, electrolytic, lb.	$0.05½–.....	$0.05½–.....	$0.06½–.....
Aluminum, 96-99%, lb.	.229–.....	.229–.....	.233–.....
Antimony, Chin. and Jap., lb.	.05½–.....	.055–.....	.06½–.....
Nickel, 99%, lb.	.35 –.....	.35 –.....	.35 –.....
Monel metal blocks, lb.	.28 –.....	.28 –.....	.28 –.....
Tin, 5-ton lots, Straits, lb.	.22½–.....	.23½–.....	.20½–.....
Lead, New York, spot, lb.	.C3–.....	.0315–.....	.0385–.....
Zinc, New York, spot, lb.	.035–.....	.037–.....	.035–.....
Silver, commercial, oz.	.24¾–.....	.27 –.....	.29¼–.....
Cadmium, lb.	.55 –.....	.55 –.....	.55 –.....
Bismuth, ton lots, lb.	.85 –.....	.85 –.....	1.50 –.....
Cobalt, lb.	2.50 –.....	2.50 –.....	2.50 –.....
Magnesium, ingots, 99%, lb.	.30 –.....	.30 –.....	.30 –.....
Platinum, ref., oz.	30.00 –.....	33.00 –.....	40.00 –.....
Palladium, ref., oz.	17.00 – 18.00	18.00 – 19.00	19.00 – 21.00
Mercury, flask, 75 lb.	48.00 – 49.00	49.00 – 50.00	67.00 – 69.00
Tungsten powder, lb.	1.45 –.....	1.45 –.....	1.45 –.....

Ores and Semi-finished Products

	Current Price	Last Month	Last Year
Bauxite, crushed, wks., ton.	$6.50 –$8.25	$6.50 –$8.25	$6.50 –$8.25
Chrome ore, c. f , post, ton.	16.50 –19.00	16.50 –19.00	19.50 –24.00
Coke, fdry., f.o b. ovens, ton.	3.25 – 3.75	3.25 – 3.75	3.25 – 3.75
Fluorspar, gravel, f.o.b. Il ., ton.	17.25 –20.00	17.25 –20.00	17.25 –20.00
Manganese ore, 50% Mn., c.i.f. Atlantic Ports, unit.	.23 –.....	.23 – ...	.25 – .27
Molybdenite, 85% MoS_2 per lb. MoS_2, N. Y., lb.	.45 –.....	.45 –.....	.45 –.....
Monazite, 6% of ThO_2, ton.	60.00 –.....	60.00 –.....	60.00 –.....
Pyrites, Span. fines, c.i.f., unit.	.13 –.....	.13 –.....	.13 –.....
Rutile, 94-96% TiO_2, lb.	.10 – .11	.10 – .11	.10 – .11
Tungsten, scheelite, 60% WO_3 and over, unit.	7.50 – 9.75	7.50 – 9.75	10.50 –12.00

INDUSTRIAL NOTES

ARMOUR FERTILIZER WORKS on Jan. 1 will move its general offices from Chicago to Atlanta, Ga.

IMPERIAL CHEMICAL INDUSTRIES LTD. has moved its offices in New York to 285 Madison Avenue.

UNION STEEL CASTING CO., Pittsburgh, Pa., has elected Merrill G. Baker as president of the company. Mr. Baker recently served as assistant to the vice-president of Ford, Bacon & Davis, Inc., New York, and is a former vice-president of the Vanadium Corporation of America.

DOW CHEMICAL CO., Midland, Mich., has organized the firm of Dowell, Inc. to manufacture, sell, purchase, and deal in acids and equipment for the treatment of oil and gas wells. Willard H. Dow is president of the new company.

CALCO CHEMICAL CO. a branch of American Cyanamid Co. has acquired the Noil Chemical & Color Works, New York. Operations at the Noil plant will be continued as heretofore.

THE SINCLAIR GLASS COMPANY plant at Corning, N. Y., is to be taken over and made ready for operation early in 1933 by a new company which has been formed for the purpose.

THE FALK CORPORATION, Milwaukee, Wis., announces the appointment of G. J. Sturmfelsz as representative in the Baltimore district and likewise the appointment of H. Douglas Stier in the Atlanta territory.

THE WORTHINGTON PUMP AND MACHINERY CORPORATION recently announced the appointment of Hugh Benet as manager of its Harrison, N. J., works. Mr. Benet had managed the Holyoke plant of the company since 1927.

THE STACEY BROS. GAS CONSTRUCTION CO., Cincinnati, Ohio, has moved its New York office to 24 State Street. William S. Guitteau is eastern manager of the company.

THE WEST COMPANY, Boston, Mass., has purchased all the formulas, machinery and equipment owned and formerly used by the H. T. West Company for the manufacture of rosin oils and pitches, and also all trade records, trade secrets, and customers' contracts of the old company, which has been liquidated.

NEW CONSTRUCTION

Where Plants Are Being Built in Process Industries

	This Month		Year to Date	
	Proposed Work and Bids	Contracts Awarded	Proposed Work and Bids	Contracts Awarded
New England.....	$140,000	.....	$1,820,000	$395,000
Middle Atlantic.....	686,000	$221,000	4,287,000	5,856,000
Southern.....	6,528,000	605,000	8,760,000	1,182,000
Middle West.....	103,000	.....	2,154,000	2,468,000
West of Mississippi	21,658,000	897,000	41,353,000	2,795,000
Far West.....	8,078,000	.....	12,486,000	931,000
Canada.....	1,103,000	35,000	11,303,000	8,120,000
Total.....	$38,296,000	$1,758,000	$82,163,000	$21,747,000

PROPOSED WORK BIDS ASKED

Alcohol Plant—American Commercial Alcohol Corp., Delaware Ave. and Tasker St., Phila., Pa., plans the construction of a 2 story manufacturing building at Delaware Ave. and Tasker St. Estimated cost $200,000.

Benzol Plant — Municipality of Budapest, Hungary, had plans prepared for benzol plant to function in conjunction with municipal gas works. Output will be utilized by municipal bus lines and Hungarian Air Corps.

Chemical Products Factory — Dow Chemical Co., Midland, Mich., have plans prepared for construction of a 1 and 2 story, 100 x 120 ft. organic products factory. Private plans. Estimated cost $35,000.

Gas Plant—New York Power & Light Co., 126 State St., Albany, N. Y., contemplates the construction of a gas plant at North Greenbush, N. Y. Estimated cost to exceed $28,000.

Gas Plant—City, Marion, Ia., E. E. Parsons, City Clerk, plans to install gas plant and distribution system. Howard R. Green Co., 417 First Ave., S. E., Cedar Rapids, submitted preliminary report.

Gas Plant — City, Modesto, Calif., will purchase and extend privately owned plant of Modesto Gas Co. and operate as a municipal project. F. J. Rossi is city engineer.

Laboratory—Thomas A. Edison, Inc., Lakeside, Orange, N. J., plans the construction of a laboratory and exhibition building at the World Fair Grounds, Chicago, Ill. Estimated cost $28,000. Carl Longefeld, 420 Lexington Ave., New York, N. Y., is architect.

Leather Factory—Amdur-Limon Leather Co., Peabody, Mass., plans constructing a tanning and leather works plant at Walnut and Wallis Sts. To exceed $100,000.

Leather Plant—J. A. Webb Leather Belting Co., 45 Pearl St., Buffalo, N. Y., plans the construction of a plant. Estimated cost to exceed $30,000 or more.

Paint Plant—Atlantic Varnish & Paint Co., Richmond, Va., plans the construction of a plant at Lester and Pearl Sts. Estimated cost $28,000 or more.

Paint Factory—J. J. Hockenjos, 829 Broad St., Newark, N. J., had plans prepared by Henry D. Scudder, Jr., Archt., 9 Clinton St., Newark, N. J., for paint factory on Frelinghuysen Ave., Newark. Estimated cost $100,000.

Linoleum Factory—L. S. Rosener, Engr., 233 Sansome St., San Francisco, Calif., is receiving bids for addition to factory of Paraffine Companies, Inc., 475 Brannan St., San Francisco, manufacturers of linoleum. Estimated cost $50,000.

Paper Mill—The Erving Paper Co., M. Housen, Supt., Erving, Mass., are having preliminary plans prepared by Raymond E. Palmer, 58 Suffolk St., Holyoke, Mass., for an addition to its paper mill. Estimated cost to exceed $40,000.

Oil Refinery—Quaker State Oil Refining Co., c/o T. M. Koch, Oil City, Pa., plans constructing addition to refinery including equipment at Farmers Valley, Pa. Estimated cost $300,000.

Refinery—Sherwood Refining Co., Warren, Pa., plans replacing and purchase of 2 stills.

Oil Refinery — Independent Oil Co., Troup, Tex., plans the contruction of a refinery at Big Sandy, Tex. Estimated cost $75,000.

Refinery — Shell Oil Co., Shell Bldg. San Francisco, Calif., plans to expend $8,000,000 during 1933 for extending and improving its producing refining and distributing facilities throughout the Pacific Coast.

Refinery—Sinclair Refining Co., 1301 Gratiot St., St. Louis, Mo., and 1907 Grand Ave., Kansas City, Mo., plans to expend $20,000,000 for expansion and modernization of refineries in various parts of the country. H. F. Nelson is manager for St. Louis office.

Rubber Factory—Lee Tire & Rubber Co., Jefferson City, Mo., plans to repair its factory recently damaged by fire. Estimated cost $30,000.

Tin Mine Development—O. R. Rudisail, Greenville, S. C., representing group of South Carolina citizens plans developing 1,000 acre tin mine near Goodwater in Coosa County. Estimated cost $5,000,000.

Whale Oil Refinery—Owner, c/o J. M. Davidson, Secy. and Mgr. of Industrial Development Board of Manitoba, Winnipeg, Man., plans the construction of a large whale oil refinery in Churchill, Man.

Ore Concentration Mill—Noranda Mines, Ltd., Noranda, Que., plans to expend $575,000 to improve its plants, including ore concentration mill and smelter plant. First unit included in above amount, already completed.

Concentration and Ore Mill—Ventures, Ltd., Concourse Bldg., Toronto, Ont., plans the construction of a concentration and ore mill at Island Lake, Man. Estimated cost $28,000.

Sulphur Plant—Freeport Sulphur Co., Freeport, La., and 122 East 42nd St., New York, N. Y., plans the construction of a sulphur mining plant at Lake Washington, Plaquemines Parish, La. Estimated cost $1,500,000. Bids will be taken about Jan. 1. J. F. Coleman Engineering Co., New Orleans Bank Bldg., New Orleans, La., is engineer.

Tire Plant—The Camel Rubber Co., Inc., Akron, Ohio, has leased and will alter and equip for special production the plant of the Bedford Tire & Rubber Co. at Bedford, Va. Estimated cost about $40,000.

Quartz Mill Machinery—Minnesota Mining & Manufacturing Co., Forest St., St. Paul, Minn., will soon takes bids for new machinery for quartz mill.

CONTRACTS AWARDED

Ammunition Depot—Bureau of Yards & Docks, Navy Dept., Washington, D. C., awarded contract for improving 15 buildings at Naval Ammunition Depot, Iona Island, N. Y., to Charles Anderson, Ft. Montgomery, N. Y. Estimated cost $46,345.

Abrasives Plant—Minnesota Mining & Manufacturing Co., St. Paul, Minn., awarded contract for constructing addition to abrasives plant, to Wm. M. Murphy & Son, Pioneer Bldg., St. Paul, Minn. Estimated cost to exceed $28,500.

Cyanide Process Plant—Homestake Mining Co., Lead, S. D., plans constructing rare metals (cyanide process) plant. Work will be done by day labor and separate contracts. Estimated cost $200,000.

Chemical Plant—Daniel Dooley, Bayonne, N. J., will construct a 2 story plant at Wayne St. and Mill Rd., Jersey City, N. J., to be leased to Titan Chemical Products, Inc., same address. Work will be done by day labor. Estimated cost with equipment $28,000.

Chemical Plant—Durolac Chemical Corp., 71 Paris St., Newark, N. J., awarded contract for plant at 84 Lister Ave., to Willard Wharton, 228 Little St., Belleville, N. J. Estimated cost $40,000.

Gas Plant—Southern Engineering & Management, Jacksonville, Fla., plans gas plant and distribution system in Melbourne and Eau Gallie. Work will be done by day labor and separate contracts. Estimated cost $40,000.

Laboratory—Board of Chosen Freeholders, Court House, Jersey City, N. J., awarded contract for 2 story laboratory at Laurel Hill, Secaucus, N. J., to Frank Crahay, 3572 Blvd., Jersey City, N. J. Estimated cost $28,500.

Laboratory—Krebs Chemical Co. (subsidiary of du Pont Co.), awarded contract for 2 story brick and steel research laboratory at New Port, Del., to Austin Co., Philadelphia, Pa. Estimated cost with equipment to exceed $50,00.

Laboratory—Wake Forest College, Wake Forrest, N. C., awarded contract for new building to be known as Johnson Medical Building to George W. Kane Co., Durham, N. C. Will be in the market for laboratory and other medical equipment. Estimated cost $65,000.

Paint and Varnish Plant—Industrial Paint & Varnish Co., 3260 East Biddle St., Baltimore, Md., awarded contract for the construction of plant extensions to J. L. Schnader, Berkshire Rd., Baltimore, Md. Estimated cost $28,000.

Paper Plant—Bogalusa Paper Co., M. E. Cody, Gen. Mgr., Bogalusa, La., is building an addition to its paper plant by day labor. Work is being done under supervision of United Engineers & Constructors, Inc., 112 North Broadway, Philadelphia, Pa.

Distillation Unit—Anderson-Prichard Oil Co., Cyril, Okla., awarded contract for distillation unit at refinery here to Winkler-Koch Engineering Co., Oklahoma City, Okla. Estimated cost $28,000.

Refinery—Eastern Refineries, Ltd., 100 Adelaide St. W., Toronto, Ont., awarded contract for refinery and service station on Danforth Ave., to H. Walker, Kingston Rd., Toronto. Estimated cost $35,000

Refinery—McNutt Oil & Refining Co., C. M. McNutt, Pres., El Paso, Tex., awarded contract for oil refinery to Petroleum Engineering Co., Dallas, Tex. Estimated cost $100,000.

Refinery—Sinclair Refining Co., Fort Worth, Tex., plans improvements to its refinery here, including cracking unit and auxiliary equipment. Estimated cost $500,000. Also plans improvements to refinery at Houston. $40,000. Work will be done by day labor and separate contracts.

ADVERTISEMENTS — *Each article on this page is a paid advertisement.*

SOLVENT NEWS

DECEMBER ★ A Monthly Series of Articles for Chemists and Executives of the Solvent-Consuming Industries ★ 1932

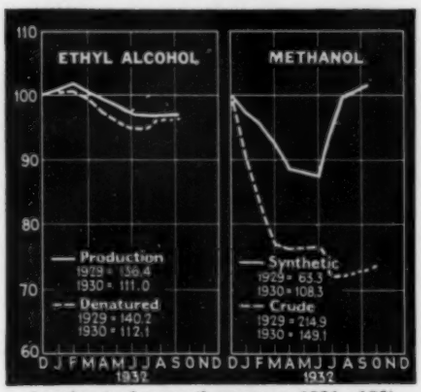
SEASONAL FACTORS AFFECT DISTRIBUTION OF SOLVENTS

Seasonal influences have worked in favor of a wider distribution of solvents which find an outlet in the anti-freeze trade. Likewise seasonal factors have brought some reduction in consumption of raw materials in branches of the leather, textile and other manufacturing lines. Producers of rayon have maintained a high rate of operation and have been ordering deliveries of solvents in undiminished volume.

Automobile production which reached the low point of the year in October, has turned sharply upward with a corresponding enlargement in demand for lacquers.

With consuming industries well covered over the remainder of the year, trading interest in the market for solvents has centered in deliveries over the first part of next year. In the majority of cases, solvents are offered for first quarter of 1933 at the prices prevailing in the current market.

Alcohol prices for deliveries during January, February and March 1933 are quoted on the same basis as priced for the fourth quarter of 1932.



(moving twelve-month averages, 1931 = 100)

CURRENT PRODUCTION

		1932	1931
ETHYL ALCOHOL			
Pure	Jan.-Sept.	102,933	107,340
1000 proof	August	12,365	12,363
gallons	September	13,355	12,952
Denatured	Jan.-Sept.	49,010	51,603
1000 wine	August	8,172	6,636
gallons	September	6,633	6,922
METHANOL			
Crude	Jan.-October	1,969	2,810
1000	September	98	134
gallons	October	249	184
Synthetic	Jan.-October	6,458	6,315
1000	September	698	663
gallons	October	571	510

ALCOHOL CHART OF EDUCATIONAL USE

A professor of bacteriology in the University of Colorado has made good use of the chart on the production of industrial alcohol. As a lantern slide, it has proved to be a valuable addition to his material on the use of micro-organisms in industry.

Other industrial and commercial consumers have found this production flowsheet of unusual value and interest. Several universities and scientific schools have employed the chart in their technical courses. It is available, ready for mounting, free of charge, for educational purposes, from the U. S. Industrial Alcohol Co.

* * *

Commercial Vitamin Concentrates may be prepared by extraction from dried vegetables with fat solvents. Vitamin A is now offered in crystals, in oil solution, or with cod liver oil.

MANUFACTURER HELD LIABLE FOR TAX ON CONSIGNMENTS

The Bureau of Internal Revenue has recently ruled that manufacturers are liable for the federal excise tax on goods shipped on consignment, even though the wholesaler or dealer who makes the sale neglects to notify the manufacturer of the sale. This ruling also subjects the manufacturer to penalties and interest charges.

IMPROVED DIAMYL PHTHALATE AVAILABLE AT LOWER COST

Largely as a result of demands for higher quality plasticizers, particularly for use in the production of coated papers for food-wrapping purposes, the U. S. Industrial Chemical Co. has developed a materially improved Diamyl Phthalate.

The quality has been improved by reducing the color, odor and volatile matter, and by increasing the ester content to between 99 and 100%. Intensive research has at the same time made it possible to reduce the price of Diamyl Phthalate.

Phthalate plasticizers have long been recognized and widely employed in the industries using cellulose nitrate and cellulose acetate. In this group, Diamyl Phthalate has always been considered the best nitrocellulose plasticizer, and now that the price has been reduced, its popularity will no doubt increase.

ALCOHOL BEST IODINE SOLVENT

Recent examination of various solvents from the standpoint of non-irritation, penetration and stability show alcohol to be the most satisfactory solvent for iodine. It was found that iodine deteriorates less rapidly and passes through animal membranes faster if KI is present in sufficient quantity to form, theoretically, KI_3. The ideal preparation suggested contains 20 grams of iodine, 24 grams of potassium iodide and 48% alcohol to make 1000 c.c.

* * *

"Pearl" Essences for plastics and lacquer require over two million pounds of fish scales annually. A new German lacquer process may increase this demand.

INHIBITOR HALTS GUM FORMATION BY UNSATURATED HYDROCARBONS

Consumers of hydrocarbon solvents and fuels in which unsaturated petroleum fractions are present—especially cracked gasolines—have been troubled by gum formation during storage. Air oxidation of the unsaturated constituents is generally considered the cause of this troublesome and expensive side reaction.

It is reported that an inhibitor has been developed whose presence in very small concentration is sufficient to prevent oxidation of the olefines to gums. Inhibitors, sometimes known as "anti-catalysts," do not take part in desired reactions, but prevent undesired reactions taking place.

This new inhibitor is a liquid of similar properties to cracked gasoline which will vaporize with the fuel, and is claimed to save the cost of present gum treatment and removal methods, avoid volumetric losses, and preserve anti-knock value.

Solvent users are watching inhibitor research work with interest. Previous success with anti-oxidants in rubber and transformer oils and other types of inhibitors to protect textiles and dyes against ultra-violet light may forecast important developments in other fields. Considerable work has already been done on the general problem of corrosion resistance, particularly on paint and varnish films.

New dust recovery method has been devised to collect pigment dust from spray painting operations. It includes a chamber carrying a rotating disk. At the center, a scraper is mounted to remove the dust, which falls into a vessel containing the solvent.

* * *

Canadian tariff cut. The Department of National Revenue has reduced the tariff on mixtures of methanol and acetone, containing not more than 15% weight of acetone, imported for leather-dyeing from 30¢ to 20¢ a gallon.

* * *

We Lead World In Utilizing Ethylene . . . . the Northeastern section of the American Chemical Society was told at a recent meeting in Boston. The uses mentioned ranged all the way from artificial ripening of fruit to manufacture of automobile anti-freeze. As an anesthetic, ethylene has proved productive of less nausea than ether. Ethylene oxide is being employed as an insect fumigant.

American chemists were credited with being from one to five years ahead of the rest of the world in developing new tools for science and industry from ethylene and allied substances.

Here's a view of a section of the world's largest vinegar plant, for the production of acetic acid used in the manufacture of invaluable acetate esters. It is a part of the Baltimore plant of the U. S. Industrial Chemical Co., Inc. The tubs on top of the huge vats contain alcohol, which is distributed by revolving arms underneath the vat covers. This alcohol runs over beechwood shavings impregnated with bacterial catalysts with which the vats are packed. Air entering from the bottom of the vats completes the process of converting the alcohol into dilute acetic acid (vinegar), which is practically chemically pure.

DECEMBER ★ **SOLVENT NEWS** ★ 1932

LOW SURFACE TENSION BEST FOR COSMETICS

According to a leading cosmetic chemist, the effectiveness of many toilet preparations and antiseptics depends to a large extent upon a low surface tension. What surface tension means is the force which causes the molecules at the surface of a liquid to draw together. Roughly, it can be compared to a weak or strong surface film.

Now, when a liquid is applied, to the skin for cosmetic or antiseptic effect, it should come into intimate contact with the entire surface, and penetrate the pores deeply. Too high a surface tension prevents this.

The solvents used in the cosmetic industry vary considerably in this important property, but are rarely measured accurately for surface tension. This can be done, however, easily and quickly with a tensiometer.

The surface tensions of several of the generally used solvents at about room temperatures are:

	dynes per cm.
Ether	16.8
Ethyl Alcohol	21.7
Methyl Alcohol	23.0
Acetone	23.3
Turpentine	27.1
Benzene	29.4
Olive Oil	33.5
Glycerine, Pure	65.2
Water	72.8

SOLVENT PRICE TREND

Coal-tar solvents continue to hold a steady price position and this is true not only for the spot market but also applies to contracts for delivery over the first part of next year—Petroleum solvents show an easy undertone but were quotably unchanged.

The most important price change of the month was reported for ethyl acetate which was reduced one-half cent a pound for round lots. The index number declined from 97.35 to 97.20.

A new process silk which is claimed to be impervious to air and water is being used in recently marketed raincoats. The basic chemical process is said to be applicable to any weight of fabric and, without impairing strength or heat and cold resistance, renders the treated material air-proof, waterproof, impervious to solvents and cleaning chemicals —even strong acids, alkalis and toxic gases.

TECHNICAL DEVELOPMENTS

Solvents in Nitrocellulose Films as well as the nitrocellulose used influence the strength and elasticity of films. German tests confirm these relationships by evaporation-rate data.

* * *

Excess of solvents over diluents is essential to satisfactory nitrocellulose lacquers, British tests show. Results indicate that the power of the solvent must be superior to that of the diluent, and that evaporation rates must be controlled to prevent sudden changes during film formation.

* * *

Solvents Aid Separation of rare-earth elements. Differential solvent action has made possible the separation of salts of the fifteen rare earth elements, ethyl ether and alcohol proving especially useful.

* * *

Colored Tires to match car finishes are now available. Special permanent colors are incorporated in side walls by a tire producer. Ordinary tires may be matched to any body color by a new lacquer base finish now on the market. This liquid finish is elastic, color fast, easily cleaned and polished due to wax in formula.

* * *

Lacquer Veneer process for applying decorative designs to sheet steel and other metals has been developed. The method is a development of the decalcomania principle. Wide choices of design and color are possible, and it is claimed the resultant sheets may be formed by usual stamping and drawing operations without marring the veneered surface.

* * *

New formulae have been developed and retentions calculated for the evaporation rate decreases caused by the addition of certain waxes and carbohydrates to solvents. They are of interest where retarded drying time is desirable in finishers, polishes and paint removers.

* * *

Normal amyl alcohol is reported to be the best alcohol solvent for Cholesterol, a new valuable cosmetic ingredient. The amyl alcohol solubility is given as 10.55% as compared with isobutyl alcohol at 6.24% and ethyl alcohol at 1.55%.

* * *

Synthetic perfume materials lead natural ones in volume today, it is reported, but synthetic chemistry has not yet been able to produce the "natural" effects alone according to leaders in the perfumery field.

PREVENTS SKIN ON PAINT

Manufacturers and users of ready mixed paints in England by employing carbon dioxide prevent the usual formation of surface skin.

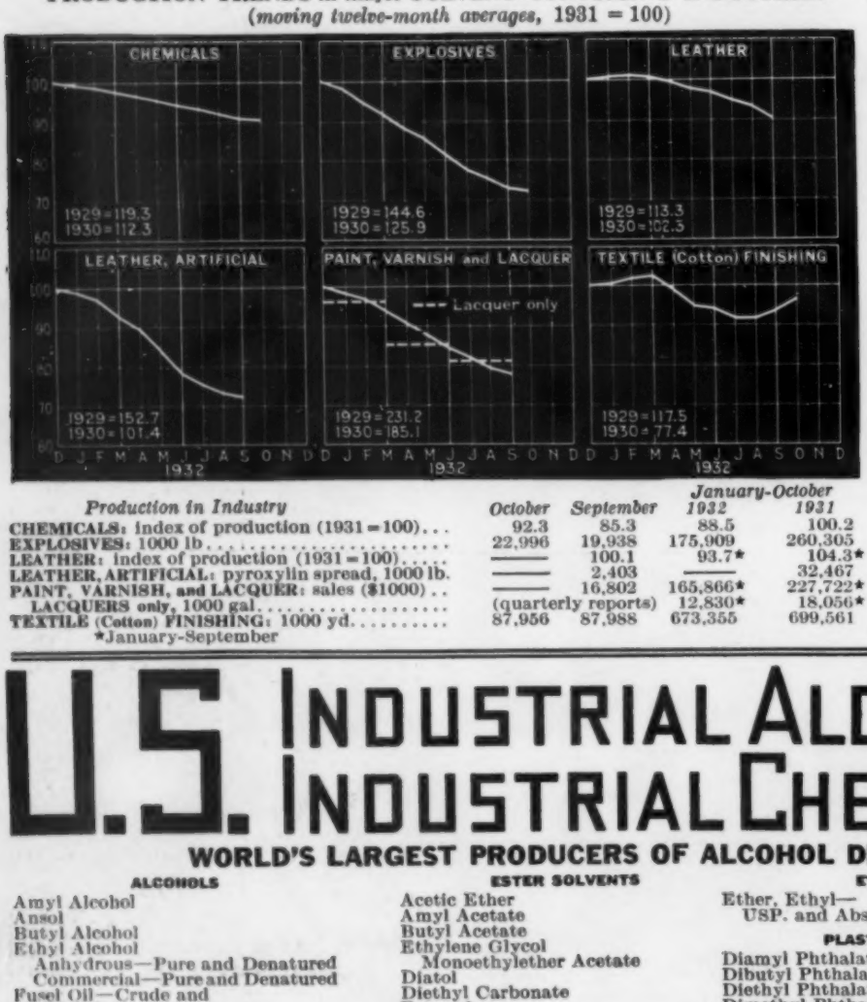
Skin formation is thus avoided when the paint has to stand over nights or week-ends.

The skin is formed by oxidation of the drying oil. The paint maker simply purges the container of air by substituting a carbon dioxide atmosphere over the paint whenever interruptions occur in the mixing operations.

It has been suggested that the same result can be procured by merely adding solid CO_2 to the paint container.

PRODUCTION TRENDS in major SOLVENT-CONSUMING INDUSTRIES

(moving twelve-month averages, 1931 = 100)



Production in Industry	*October*	*September*	*January-October 1932*	*January-October 1931*
CHEMICALS: index of production (1931 = 100)	92.3	85.3	88.5	100.2
EXPLOSIVES: 1000 lb	22,996	19,938	175,909	260,305
LEATHER: index of production (1931 = 100)	———	100.1	93.7★	104.3★
LEATHER, ARTIFICIAL: pyroxylin spread, 1000 lb.	———	2,403	———	32,467
PAINT, VARNISH, and LACQUER: sales ($1000)	———	16,802	165,866★	227,722★
LACQUERS only, 1000 gal	(quarterly reports)		12,830★	18,056★
TEXTILE (Cotton) FINISHING: 1000 yd	87,956	87,988	673,355	699,561

★January-September

U.S. INDUSTRIAL ALCOHOL CO.
U.S. INDUSTRIAL CHEMICAL CO., INC.

WORLD'S LARGEST PRODUCERS OF ALCOHOL DERIVED SOLVENTS

ALCOHOLS
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Ansol
Butyl Alcohol
Ethyl Alcohol
Anhydrous—Pure and Denatured
Commercial—Pure and Denatured
Fusel Oil—Crude and Refined
Methanol
Secondary Amyl Alcohol
Secondary Butyl Alcohol
Solox

ESTER SOLVENTS
Acetic Ether
Amyl Acetate
Butyl Acetate
Ethylene Glycol Monoethylether Acetate
Diatol
Diethyl Carbonate
Estersol
Ethyl Acetate
Ethyl Lactate
Secondary Amyl Acetate
Secondary Butyl Acetate

ETHER
Ether, Ethyl—USP. and Absolute

PLASTICIZERS
Diamyl Phthalate
Dibutyl Phthalate
Diethyl Phthalate
Dimethyl Phthalate

NITROCELLULOSE SOLUTIONS
Collodions
Cotton Solutions

CELLULOSE ACETATE
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Ethyl Chlorocarbonate
Ethyl Oxalate
Ethylene
Sodium Oxalacetate

MISCELLANEOUS SOLVENTS
Acetone
Methyl Acetone

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ON THE SPOT?

A new method of manufacture for a staple product was worked out in the laboratory of a certain chemical concern. If successful in practice, it would allow them to grind production costs to a new low,—grip more tightly their present markets.

The product required a special metal, and at the high speed necessary for separation, springing of a centrifugal's spindle (made of this metal) was believed certain. Company engineers up against it came to A T & M—told their facts in confidence.

Effects of various chemicals were tested in the A T & M laboratories—work was kept secret. Three months later a centrifugal designed throughout of the required alloy (basket, curb, discharger) passed all tests. Trouble from the spindle springing was prevented from ever occurring —steel with a 1/64" plating of the new metal accomplished the desired results.

For clarification, dehydration, extraction or separation consult with A T & M engineers. Laboratories where work is carried on in secrecy and held in confidence are at your service without obligation. Send all facts to The American Tool & Machine Company: Main Office and Plant, 1413 Hyde Park Avenue, Boston, Massachusetts; or New York Office, 30A Church Street, New York City.

A T & M design and build a complete line of centrifugals (suspended, link suspended, solid curb, specials) from 5 inches to 72 inches and larger with fume proof hoods, explosion proof motors and baskets of any type in all machinable metals and coatings.

Below—18" Suspended Centrifugal for laboratory use. Suspended centrifugals, furnished in sizes 12" to 72" and larger with motor, belt or water drive.

AMERICAN TOOL & MACHINE CO.

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CENTRIFUGALS

you should investigate METHANOL

All alcohols contain hydrocarbon and alcohol groups. METHANOL, being the simplest of all alcohols, contains the greatest percentage of alcohol groups. In fact, it is composed of 53% of the desirable, active alcohol group — while ethyl alcohol contains only 36%, isopropyl alcohol 28% and butyl only 23%. In other words, *your alcohol dollar buys the most alcohol groups when you purchase METHANOL.*

Also, it is well known that the first member of an aliphatic family exhibits properties not appearing in higher members of the series. Methanol bears out this rule as indicated by the following points of superiority over the other aliphatic alcohols —

ACETONE	METHANOL
BUTYL ACETATE	METHYL ACETATE
BUTYL ALCOHOL	METHYL ACETONE
BUTYL CARBITOL ★	METHYL CELLOSOLVE ★
BUTYL CELLOSOLVE ★	PROPYLENE CHLORHYDRIN
BUTYRALDEHYDE	PROPYLENE DICHLORIDE
CARBITOL ★	PROPYLENE GLYCOL
CARBOXIDE ★	PROPYLENE OXIDE
CELLOSOLVE ★	TRIETHANOLAMINE
CELLOSOLVE ★ ACETATE	TRIETHYLENE GLYCOL
DICHLORETHYL ETHER	VINYL CHLORIDE
DIETHYLENE GLYCOL	VINYLITE ★ RESINS
DIOXAN	ETHYLENE
ETHYL ACETOACETATE	PROPANE
ETHYL ETHER	ISOBUTANE
ETHYLENE CHLORHYDRIN	BUTANE
ETHYLENE DICHLORIDE	ETHANE
ETHYLENE GLYCOL	PROPYLENE
ETHYLENE OXIDE	ACTIVATED CARBON
ISOPROPANOL	PYROFAX ★
ISOPROPYL ETHER	★ Trade-mark Registered

1. **Its solutions freeze lower.**
2. **Methanol dissolves R.S. cellulose nitrate.**
3. **Forms no constant boiling mixture with water.**
4. **Has less grain raising action in wood stains.**
5. **The most powerful solvent for "spirit-soluble" dyes and resins.**

In addition, METHANOL has the following commercial advantages:

(a) **Better odor (no denaturants).**

(b) **It is the most economical of all alcohols.**

(c) **Requires no permit.**

(d) **It is the purest industrial alcohol—containing 99½% CH_3OH.**

CARBIDE AND CARBON CHEMICALS CORPORATION

Producers of Synthetic Organic Chemicals

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Unit of Union Carbide UCC *and Carbon Corporation*

CME-12-52

Please send price, specifications and data on Methanol to

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"I Wonder if I can Ship in Bags?"

Very likely you *can*—and save a lot of money doing it! A great variety of products are now being shipped, efficiently and economically, in Bemis Waterproof Bags. Their initial cost is low—they're easy to handle—they require little storage space—and, because they are light in weight, they lower freight costs considerably. May we lay before you our entire story? It will interest and convince you.

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BEMIS WATERPROOF BAGS

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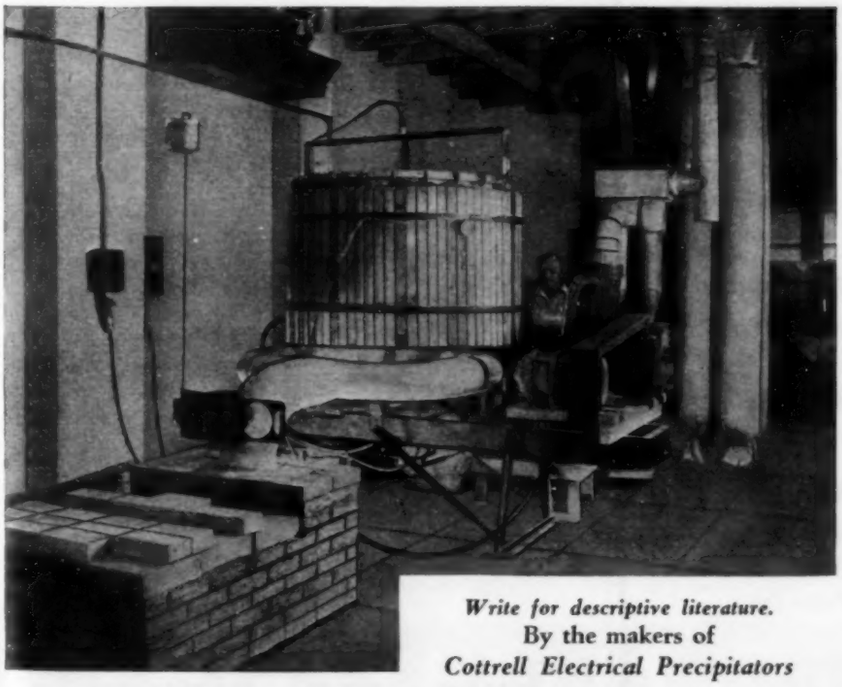
The Peebles-Western Precipitation Company

SPRAY DRYER



The application of spray drying to industry has been retarded by lack of proper laboratory scale experimental equipment. The ordinary spray dryer consists of a large chamber or flue for hot gases and a central spray for introducing the materials to be dried. When such a dryer is reduced to bring the capacity of the apparatus down to laboratory quantities, the sprayed liquid material is deposited on the chamber walls before it has time to dry. The patented principle of the Peebles spray drying system eliminates this restriction. By suitable arrangements for handling the flow of gases, the droplets from the spray or atomizer are prevented from reaching the walls before the drying is completed.

By employment of this principle, the Western Precipitation Company has developed the Peebles laboratory unit shown. The desiccating chamber of this unit is only four feet in diameter whereas the diameter of the smallest commercial Peebles unit is nine feet, and that of other makes is about twenty feet. This laboratory unit is complete with gas furnace, desiccator, multiclone and bag filter.

While ordinarily from 90% to 99% of the spray dried product in the outlet gases from the desiccator is collected in the Multiclone, the bag filter removes the small remainder and permits discharging directly into the operating room. The evaporating capacity of this laboratory unit is up to 200 pounds of water per hour. With a 20% feed, it produces 50 pounds of dried product in one hour's operation, while with a 50% feed, the production would be 200 pounds per hour.

The unit is built so that all of its parts are accessible for cleaning, thus avoiding contamination of the dried material from previous runs. The following list of materials that have been successfully dried in the laboratory unit shown indicates the possibilities of this apparatus:

BARIUM SULPHATE	LITHOPONE
CALCIUM CHLORIDE	CRUSHED ONIONS
CARBON BLACK	YEAST
COFFEE EXTRACT	ZINC CARBONATE
LIME SULPHUR	ZINC HYDROXIDE
	ZINC SULPHIDE

Write for descriptive literature.
By the makers of
Cottrell Electrical Precipitators

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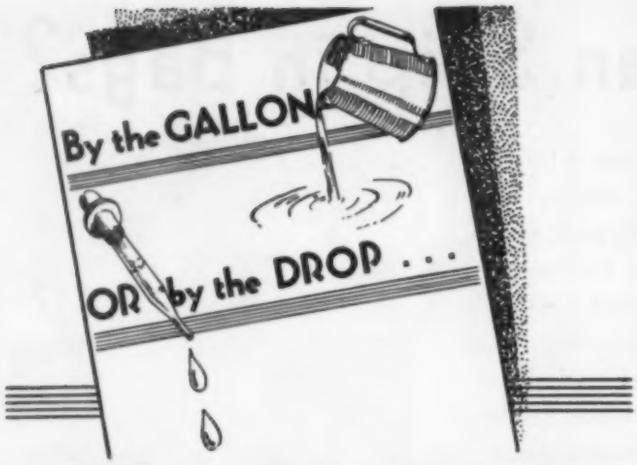

P.Q. SILICATES OF SODA

FIRST CHOICE of Laboratory and Industry

HIT-OR-MISS methods of selecting a silicate of soda or any chemical often prove expensive. The difference between a reliable chemical and one of unknown or questionable performance may be measured in hundreds of dollars damage to other materials.

For that reason, you find chemists and engineers specifying P. Q. Silicates, and plant managers, and superintendents ordering P. Q. Silicates.

P. Q. Silicates are quality controlled from raw materials to finished products. They insure uniform performance and satisfaction.

Send for Bulletin 171—a miniature Silicate of Soda Catalog.

PHILADELPHIA QUARTZ CO.

General Office and Laboratory
121 S. Third St., Philadelphia
Chicago Office, 205 W. Wacker Drive

PLANTS

Anderson, Ind.
Baltimore, Md.
Chester, Pa.
Gardenville, N. Y.
Kansas City, Kans.
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Sold in Canada by NATIONAL SILICATES LTD., Brantford, Ontario

SULPHUR

(99½% PURE)

FOR

Sulphuric Acid

Fertilizer Manufacture

Sulphite Pulp

Explosives

Insecticides

Carbon Bi-sulphide

Miscellaneous chemicals

●

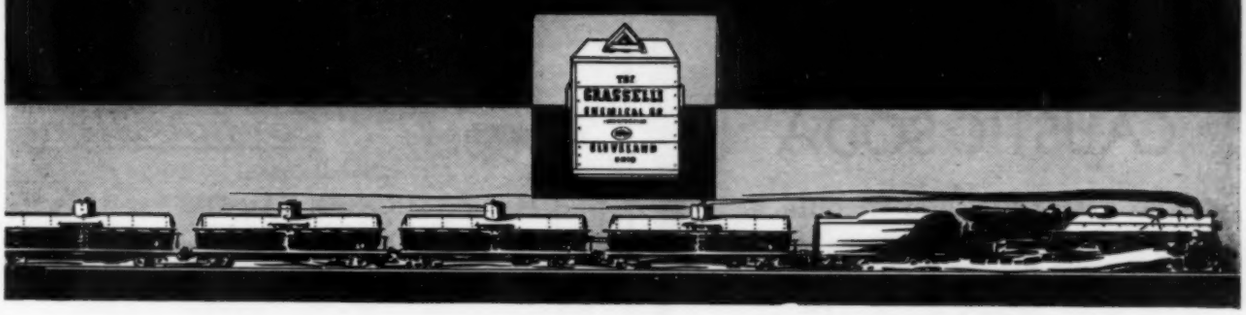
TEXAS GULF SULPHUR CO.
75 E. 45th Street New York City
Mines: Gulf, Newgulf and Long Point, Texas

GRASSELLI SERVICE

Anything in INDUSTRIAL CHEMICALS

FROM A CARBOY TO A CARLOAD

just when you want it



THE Grasselli Chemical Company affords its customers the exceptional shipping facilities of 36 warehouses and works. As these are located all over the country, there is sure to be one near you. This convenient proximity means quicker delivery, and economy of freight rate for you.

QUALITY CHEMICALS FOR MANUFACTURERS OF—

Aluminum Castings	Disinfectants	Leather	Printing Ink
Automobiles	Electrical Devices	Linoleum	Rubber Goods
Batteries	Fertilizers	Oil Refiners	Soap
Boiler Compounds	Foundries	Paint and Varnish	Spray Products
Brass	Filtration Plants	Paper	Sugar
Brick and Clay Products	Glass	Pharmaceuticals	Textiles
Concrete Highways	Glue	Photo Engravings	Tin Plate
Cleansing Compounds	Iron and Steel	Pottery	Wood Preservers
Fibre Containers	Laundry Supplies	AND MANY OTHER INDUSTRIES	

What are your needs? Write, wire or phone our nearest branch for prompt service.

THE GRASSELLI CHEMICAL COMPANY
CLEVELAND INCORPORATED OHIO

New York and Export Office: 350 Fifth Avenue

BRANCHES AND WAREHOUSES:

ALBANY BIRMINGHAM BOSTON CHARLOTTE CHICAGO CINCINNATI DETROIT MILWAUKEE NEW HAVEN NEW ORLEANS PHILADELPHIA PITTSBURGH ST. LOUIS ST. PAUL SODUS, N.Y.
SAN FRANCISCO, 576 Mission Street LOS ANGELES, 2260 East 15th Street

Represented in Canada by CANADIAN INDUSTRIES, LTD., Acids & General Chemicals Division—Montreal and Toronto

Send for booklet

GRASSELLI GRADE
A Standard Held High for 93 Years

SOLVAY PRODUCTS

TRADE MARK REG. U. S. PAT. OFF

SODA ASH and CAUSTIC SODA

The first Soda Ash manufactured in this country was produced by The Solvay Process Company at its Syracuse Plant nearly 51 years ago. Since that time the Company has been continuously producing alkalies which have established the standard of quality for the industry.

58% Light Soda Ash
58% Dustless Dense Soda Ash
Fluf (Extra Light Soda Ash)
76% Solid Caustic Soda
76% Flake Caustic Soda
76% Ground Caustic Soda,
76% Powdered Caustic Soda
Liquid Caustic Soda

SOLVAY SALES CORPORATION
Alkalies and Chemical Products Manufactured by The Solvay Process Company
61 BROADWAY, NEW YORK
Boston Syracuse Chicago Indianapolis Cleveland
Cincinnati Pittsburgh Detroit Philadelphia
Kansas City St. Louis

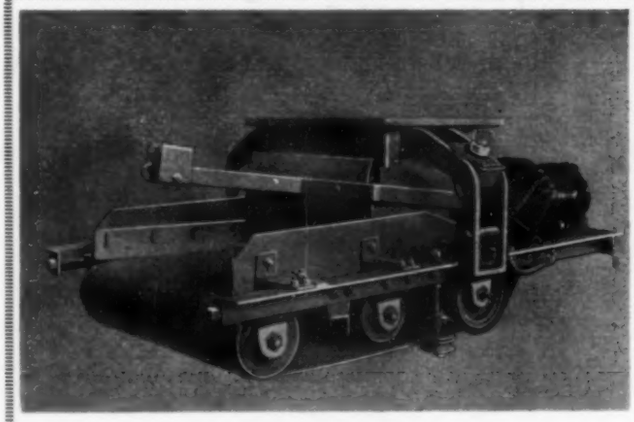
CO_2 Specialists of 40 Years Standing

Every cylinder of Red Diamond CO_2 is of the same high, uniform quality — rigidly safeguarded by laboratory control throughout every step of manufacture. "Liquid" maintains an extensive laboratory in which careful tests are made to check each day's output—and in which research engineers are constantly busy working out new applications for industrial users. Write for our booklet, "The uses of Carbon Dioxide." And consult the nearest "Liquid" office on any problem involving the use of CO_2.

"The Liquid" Carbonic Corporation
CHICAGO

General Offices:
CHICAGO, ILLINOIS

Albany	Cincinnati	Indianapolis	Nashville	Richmond
Ashland	Cleveland	Jacksonville	New Orleans	Salt Lake City
Atlanta	Columbia	Kansas City	New York	San Antonio
Baltimore	Dallas	Los Angeles	Norfolk	San Diego
Birmingham	Denver	Louisville	Philadelphia	San Francisco
Boston	Detroit	Memphis	Phoenix	Seattle
Buffalo	El Paso	Milwaukee	Pittsburgh	St. Louis
Charlotte	Havana	Minneapolis	Portland	Tampa



Weighing Feeders Replace Volumetric Feeders

2 Hardinge Constant Weight Feeders recently replaced volumetric feeders for regulation of the flow of dry material through the plant. A record of the weight was secured, but—of greater importance—the steady even flow of material measured by weight instead of volume increased mill capacity to such an extent that the Feeders paid for themselves in 4 months' time.

Write for particulars

Hardinge Company, Inc., York, Pa.

New York—122 East 42nd Street Chicago—205 W. Wacker Drive
San Francisco—235 Montgomery St.

"QUICK, WATSON—THE SCISSORS

Du Pont Anti-Freeze Methanol is a scientifically correct radiator solution for your personal car or motor vehicle fleet. It gives full protection against freezing. It prevents corrosion. It will not injure waterhose connections. It does not boil off readily. It has no unpleasant odor. Clip, fill in and mail this coupon for complete details and prices.

DU PONT

E. I. DU PONT DE NEMOURS & CO., INC., Ammonia Department, Wilmington, Delaware

Gentlemen:—Rush me, by return mail, prices and information on Du Pont Anti-Freeze Methanol.

Name_____

Address_____

City_____ State_____

Nature of Business_____

PLATINUM MASS CATALYSTS ARE BETTER AND MORE ECONOMICAL THAN SUBSTITUTES

SUBSTITUTES, as compared with platinum mass catalysts, have no advantage as regards conversion efficiency at normal flow rates. Platinum mass catalysts have a very distinct advantage in emergencies. They will take care of huge overloads, with satisfactory conversion percentages. Substitutes cannot do this.

Gas cleaning, before conversion, is essential in any well designed sulphuric acid plant no matter what catalyst is used. Unless this be done, the resulting product will not have the purity required for C. P. acid. At best, it can compete only with chamber acid.

In plain dollars and cents, platinum mass catalysts actually cost you less, because 90 per cent of the metal can be recovered. Our services are always available for reclaiming such material. The metal cost of replacements, therefore, is but 10 per cent of the original cost, plus a small refining charge. Substitutes, when outworn, are waste—nothing more.

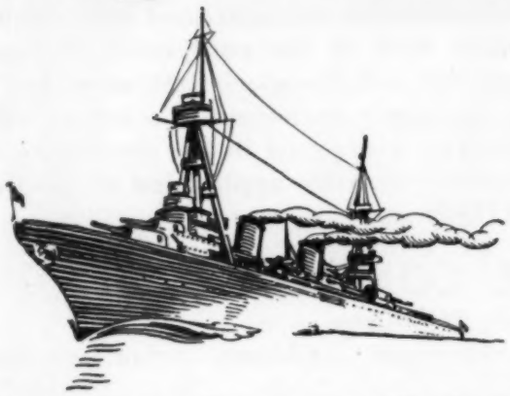
We should like very much to go into the details of this subject with you. Just tell us you are interested.

BAKER & CO., INC.
54 Austin St., Newark, N. J.

New York San Francisco Chicago

Trade BAKER Mark

If you want unbiased help in selecting Alloy Steel . .



■ With scores of alloy steels available, selecting the few that will do your job best is not easy. To give you practical and unbiased help in this task is the purpose of Electromet Engineering Service. ■ Electromet's suggestions are unbiased because Electromet is not a manufacturer of alloy steels, and favors no one producer or product. Selling ferro-alloys to makers of all kinds of steel, Electromet needs—and has—a vast fund of data on every composition. It is from this up-to-the-minute information that Electromet engineers draw when they study your problem and recommend the steel that will suit it best. ■ Taking advantage of this service will insure the results you expect from alloy steels. You are welcome to it at any time. A request on your letterhead will bring you complete information.

Electromet
Ferro-Alloys & Metals

ELECTRO METALLURGICAL SALES CORP.
Unit of Union Carbide and Carbon Corporation

UCC

CARBIDE and CARBON BUILDING, 30 EAST 42nd ST., NEW YORK, N. Y.

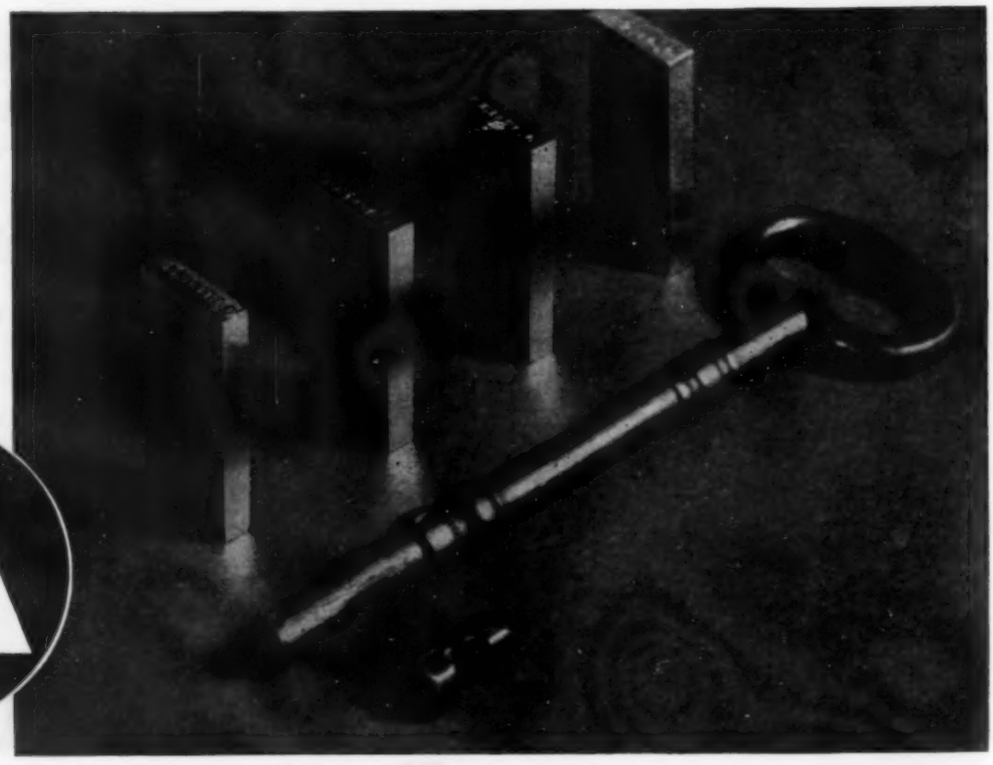
A sensible, scientific key
TO THE STEEL BEST SOLVING YOUR PARTICULAR CORROSION PROBLEM

. . . The process industries, in fact, most industries, with the development of heat resistant and corrosion resistant steel have found this material more useful than ever before both in the equipment of their plants and development of their products. But with the specialization of steel's properties and applications it becomes increasingly important to select exactly the right alloy for a specific purpose. Midvale pioneered in the development of alloy steel. It has again pioneered in steel's sensible application to specific purposes, through MIDVALOY INDICATORS.

THE MIDVALE COMPANY

Main Office and Plant: Philadelphia

New York Pittsburgh Washington Cleveland Chicago San Francisco



These four little MIDVALOY INDICATORS, exposed to the conditions in your particular process, will definitely tell you which type of steel promises best results for you. Tell us your problem and we will gladly help you solve it.

MIDVALOY *Indicators*

A Packing that Withstands the Destructive Action of Sulphuric Acid

SUPER CUTNO PACKING

is the result of long experiments to produce a packing that will give a satisfactory length of service against the most difficult of all acids — Sulphuric — and those acids similar to it, especially at elevated temperatures.

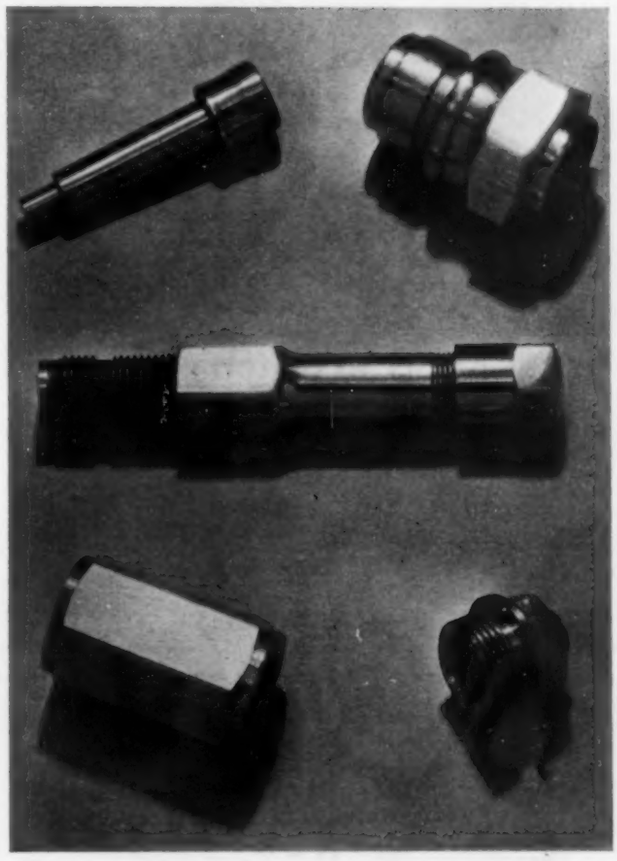
SUPER-CUTNO can be depended upon to withstand the destroying quality of Sulphuric and those acids of a similar nature and to give a length of service entirely unknown to any packing heretofore offered for this service.

We would like to send you a free working sample to test out under your own peculiar conditions.
State size and quantity required for test.

GREENE, TWEED & CO.
Sole Manufacturers
109 Duane Street
New York

SULPHURIC ACID

No Corrosion
when parts are made of
BETHADUR



So varied are the properties to be found either among the nine grades of Bethadur or in Bethalon—the latter well-known for its easy-machining qualities—that it is almost certain that you can make use of these corrosion-resisting materials for any parts in which immunity to corrosion is desirable, regardless of what may be the other requirements of the service.

Practically any of the commonly-encountered corroding agents can be successfully combated with Bethadur. The metallurgists who developed Bethadur will gladly discuss with you its possible application to your uses.

BETHLEHEM STEEL COMPANY — GENERAL OFFICES: BETHLEHEM, PA.

District Offices: New York, Boston, Philadelphia, York, Wilkes-Barre, Baltimore, Washington, Atlanta, Pittsburgh, Buffalo, Cleveland, Cincinnati, Indianapolis, Detroit, Chicago, St. Paul, Milwaukee, St. Louis, Houston, Dallas. *Pacific Coast Distributor:* Pacific Coast Steel Corporation, San Francisco, Los Angeles, Portland, Seattle, Honolulu. *Export Distributor:* Bethlehem Steel Export Corporation, New York.

BETHLEHEM

Gasoline Bubble Tower

STEEL and ALLOY STEEL PLATE FABRICATION

exactly to specifications

TANKS *and* VATS made from monel, Lukens nickel clad steel, or other metals.

Boilers—HRT
Agitator Tanks
Bubble Towers
Jacketed Kettles
Welded Steel Pipe
Creosoting Cylinders
Gas Scrubbers

R. D. COLE MANUFACTURING CO.

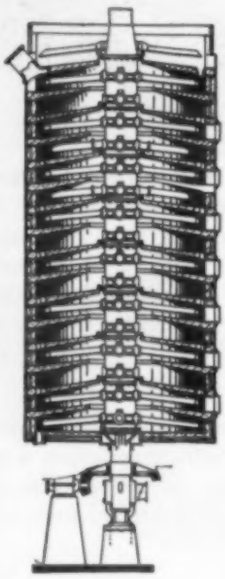
Established 1854

NEWNAN, GA.

New York Office,
5 Beekman St.

COLE

FABRICATORS OF STEEL AND ALLOY STEEL PLATE



NICHOLS HERRESHOFF FURNACE

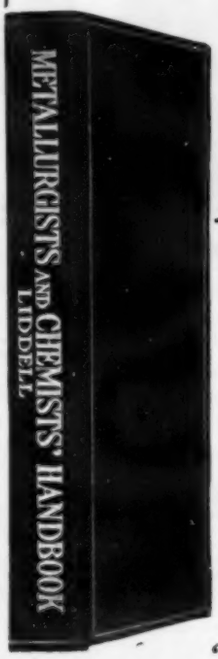
ENABLES producers to attain the economical limit of smelting. Its success at many of the world's notable metallurgical plants testifies to its definite, practical advantages in operation, capacity and adaptability. Our engineers are at your service for assistance in solving any roasting, calcining or drying problem.

NICHOLS ENGINEERING AND RESEARCH CORPORATION
New York

PACIFIC FOUNDRY COMPANY, LIMITED
San Francisco

Your name stamped on this book FREE

As a special Holiday Offer we will stamp your name or that of a friend FREE in gold on the front cover of any copy of Liddell's Handbook ordered before January 1, 1933. In addition you have this last opportunity to get this well-known handbook at the special reduced price of $3.00. Here is a happy solution of the Christmas gift-problem, and a doubly attractive opportunity to add this book to your own library. Send the coupon below.



Liddell's
Metallurgists and Chemists' Handbook

Third Edition, 847 pages, pocket size, flexible

Was $5.00—NOW $3.00

"One of the most handy and indispensable sources of information"

So says Metals and Alloys, in a review of this third edition of Liddell's Handbook. And this is only one of many comments we have received. "An especially fine reference book and contains much up-to-date information of interest not only to the chemist and metallurgist but also to the engineer"—The Foundry. "A valuable reference book"—Science News Letter. "Will be a valuable companion to the metallurgist,"—Journal of the Institute of Metals (British).

Gives quick answers to hundreds of questions on:

—mathematical data and tables
—metallurgical price and production statistics
—physical constants
—chemical data
—sampling, assaying and analysis
—ore dressing data and tables
—fuels and refractories
—cyanidation
—mechanical engineering data
—general metallurgical data
—organic chemistry
—first-aid, etc.

Do you want to make a friend a gift combining personal thoughtfulness with real utility? Do you want a copy of **Liddell's Metallurgists and Chemists' Handbook** that you will doubly prize? Then take advantage of this free stamping offer. Send the coupon today. (Proper remittance should be enclosed with orders and, of course, stamped copies are not returnable.)

SPECIAL HOLIDAY OFFER COUPON

McGraw-Hill Book Company, Inc., 330 West 42d Street, New York

Send me **Liddell's Metallurgists and Chemists' Handbook**, with name stamped in gold on the front cover. I enclose $3.00 and understand that stamped books are not returnable. (This offer expires Jan. 1, 1933.)

.....

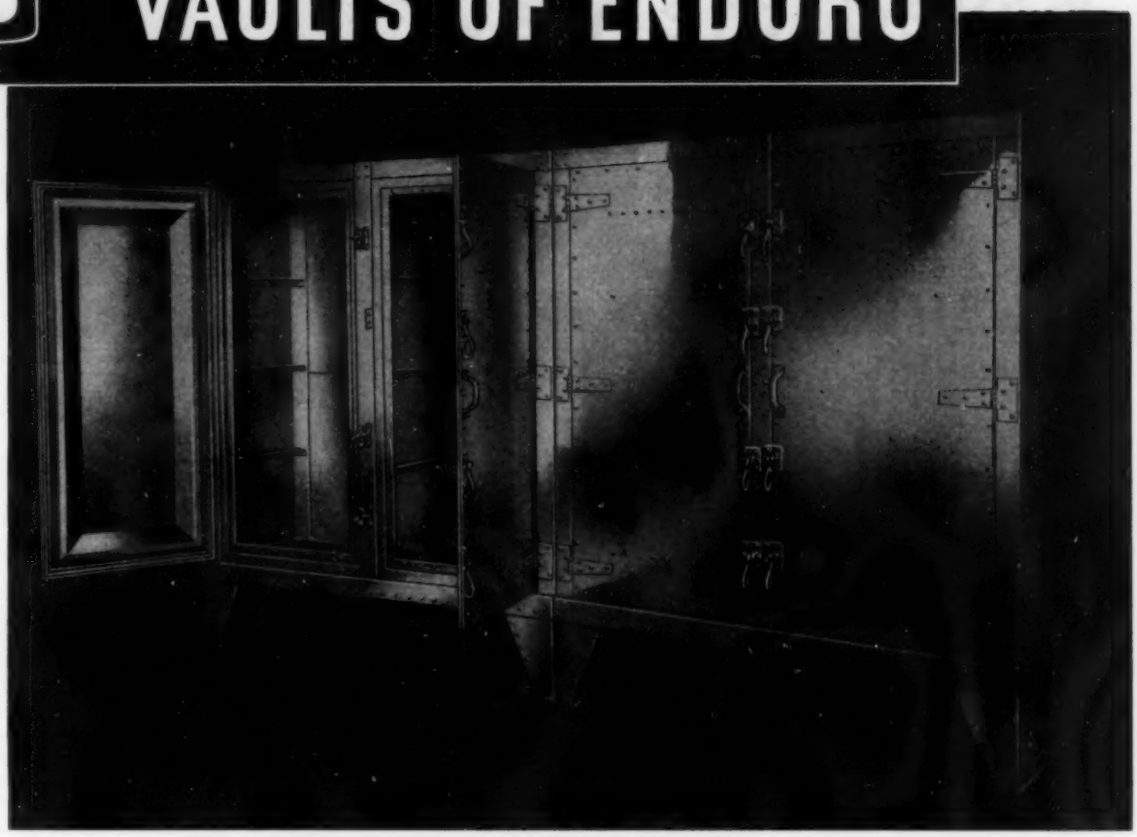
(Name to be stamped. Please print.)

Name .....

Address .....

City and State.....M. 12-32

STURDY STERILIZING VAULTS OF ENDURO



Two vaults used for sterilizing rat cages, glass ware, trays, and similar equipment were built recently for Columbia University by the East River Sheet Metal Works, New York. ENDURO, Republic's Perfected Stainless Steel, was used throughout.

These vaults are typical of many types of equipment used in chemical and research laboratories where only a metal of high corrosion resistance can be used. ENDURO is ideal for such purposes. It resists most acids, alkalies, and corrosive salts. It is stainproof, easily kept clean, and, due to its greater strength than ordinary steel, long-lasting and sturdy.

Other laboratory applications are—ventilating and fume ducts, table tops, sinks, shelves, furniture trim—in fact, any application where ordinary ferrous metal rapidly corrodes is a good place to try ENDURO—the metal that is the same all the way through.

The Republic Metallurgical Staff will be glad to make suggestions on specific applications.

ENDURO
REPUBLIC'S PERFECTED
STAINLESS STEEL

CENTRAL ALLOY DIVISION . . MASSILLON, OHIO
REPUBLIC STEEL CORPORATION

Licensed under Chemical Foundation Patents Nos. 1316817 and 1339378.

This Advertising paved the way for good 1932 business ▸ ▸ ▸ ▸

LOUISVILLE DRYER
SAVES $2,160 ANNUALLY

Product
Steam Required
Power Required
Comparative Operating Costs
SAVINGS per day with Louisville Dryer $7.20
SAVINGS per year with Louisville Dryer $2160.00

BECAUSE of the comparatively low temperature at which their product deteriorates, the first dryer purchased by an Eastern chemical company was of the so-direct warm-air type usually employed in their industry.

After a thorough examination of conditions, however, we recommended a more efficient type of dryer that is more producing, the results shown above.

In addition to saving $2160.00 a year on operating costs, the purchase price of the Louisville Dryer was $2000.00 less than the old one.

• • •

be paid for on long-term arrangements—frequently out of current savings.

WRITE for New Catalog

This company has just produced a new catalog showing several revolutionary dryer improvements developed during the past year. If you are even remotely interested in any process that involves drying, this new catalog may be of greatest interest to you. Your copy will be sent you gladly on request. No obligation of any sort. *Address:* Louisville Drying Machinery Co., *Incorporated*, 451 Baxter Ave., Louisville, Ky.

LOUISVILLE DRYERS

Chemical & Metallurgical Engineering — Vol.39, No.10

LOUISVILLE DRYING MACHINERY CO.
INCORPORATED
MANUFACTURERS OF
EVAPORATORS
DRYERS AND PRESSES
OFFICE AND WORKS
BAXTER AND HAMILTON AVES. AND HULL AND COOPER STS.
LOUISVILLE, KY., U.S.A.

August 4, 1932.

SUBJECT

Chemical & Metallurgical Engineering
McGraw Hill Building
330 West 42nd Street
New York City

Gentlemen:-

We have been consistent advertisers in your magazine for many years. However, the job which this advertising has done during the past two years is worthy of comment.

Our inquiries from all magazine advertising for the first six months of 1931 and 1932 were approximately the same. However, inquiries from Chemical and Metallurgical Engineering advertising, the first six months of 1931, represented about 9.6% of the total inquiries; for the same period of 1932, they represented 20%. This indicates that the inquiries from Chemical and Metallurgical Engineering advertising actually increased in number 80% in 1932, over the same period of 1931.

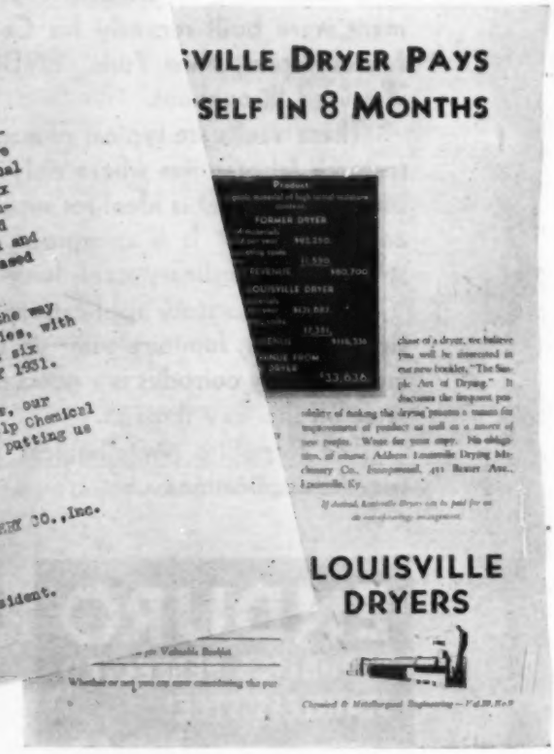
The inquiries above have led the way to an increase of our sales to the process industries, with the gratifying results that financially, the first six months of 1932 are far ahead of the same period of 1931.

In view of the above results, our enthusiasm for the process industries and the help Chemical and Metallurgical Engineering has been to us in putting us in touch with the same, is understandable.

Very truly yours,
LOUISVILLE DRYING MACHINERY CO., Inc.
By A. W. Lissauer, President.

AWL
K

These are recent advertisements of the Louisville Drying Machinery Co., who have advertised in "Chem. & Met." for a number of years. This advertising is handled by the Elmer H. Doe Advertising Agency, Louisville, Ky.


SVILLE DRYER PAYS
SELF IN 8 MONTHS

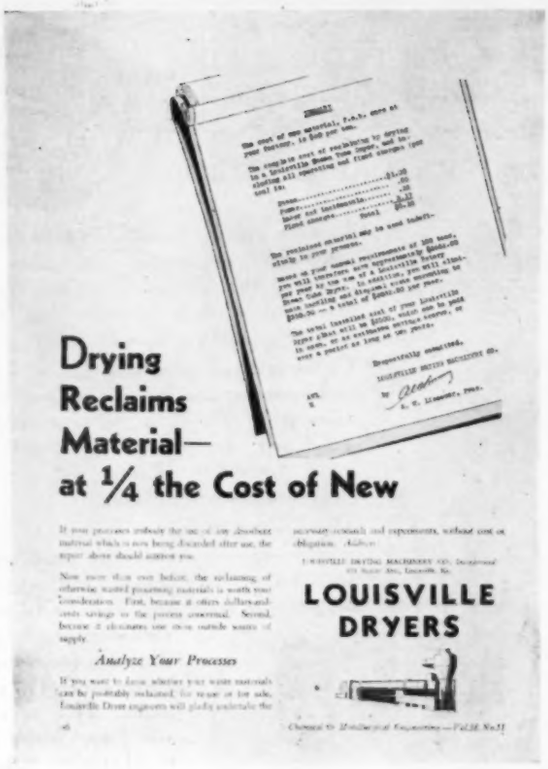
Product
FORMER DRYER
LOUISVILLE DRYER
$33,636

chase of a dryer, we believe you will be interested in our new booklet, "The Simple Art of Drying." It discusses the frequent possibility of making the drying process a means for improvement of product as well as a source of new profits. Write for your copy. No obligation, of course. Address Louisville Drying Machinery Co., Incorporated, 451 Baxter Ave., Louisville, Ky.

If desired, Louisville Dryers can be paid for on an extended payment arrangement.

LOUISVILLE DRYERS

Chemical & Metallurgical Engineering — Vol.39, No.9



There is no half-way, no half-hearted acceptance of advertising on the part of the management of the Louisville Drying Machinery Company. As a result there was, instead of a falling off in sales, a decided increase in sales in 1932 compared with 1931, based on the first six months' period.

This is just another instance of what advertising means to business when it's made part and parcel of that business—when it's conceived as an integral part of management—when it's planned and scheduled just as the other major operations of that business are planned and scheduled. One might as well go half-way in organizing plant layout and production facilities as to go half-way in the job of organizing a market and in influencing the minds that constitute that market.

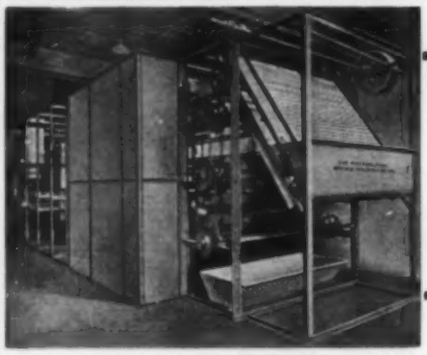
Any manufacturer can do what the Louisville Drying Machinery Company has done—if his product is right.

CHEMICAL
& METALLURGICAL
ENGINEERING
A McGRAW-HILL PUBLICATION
330 West 42d Street, New York

A.B.C. A.B.P.

What's Ahead?

The January issue of "Chem. & Met." will take a long look ahead at what's in store for the process industries. It will be a whale of an issue in which to launch an advertising campaign for increased 1933 profits. Because it is going to have that kind of readership that a publication always has when it discusses the readers' customers. "Chem. & Met." editors will discuss the rising tide of textiles, the place of the automobile in business recovery, the immediate and the ten-year outlook for iron and steel, trends in other industries that utilize the products of the process industries. First advertising forms close December 27; final forms close January 5.



"Hurricane" Multiple-pass Automatic Tray Dryer

Panels removed to show construction.

CONTINUOUS DRYERS

LOWER COSTS

MANY products can be dried in Continuous Automatic machines at a great saving in time, labor and floor space. "Hurricane" Continuous or Automatic machines are made in many models:

Automatic Dryers of the tray type for chemicals;
Continuous Conveyor Dryers for ceramic products and enamel ware;
Pole and Chain Dryers for yarns;
Automatic Loop Dryers for fabrics;
Apron Machines for fibrous materials, etc.

We also build Tray Dryers and Tunnel Truck Dryers for manual operation.

Write for Bulletin Ind-1: "Dryers for the Industries." 241

THE PHILADELPHIA DRYING MACHINERY CO.

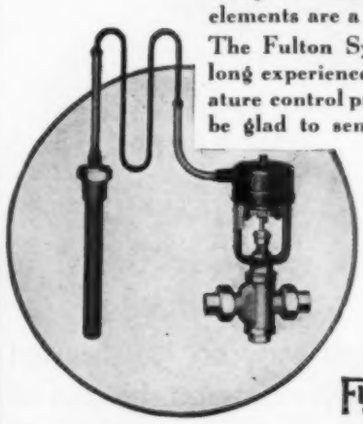
3351 Stokley St., Philadelphia, Pa.

UNIFORM PROFITS LIKE UNIFORM QUALITY - - - *depend on* TEMPERATURE CONTROL

FULTON Sylphon FOR TEMPERATURE CONTROL

Under present conditions many manufacturers in many industries are learning the necessary part temperature control plays in producing better products at lower cost.

Uniformity of products, fewer rejects and seconds and lower fuel and labor costs are a few of the advantages that automatic temperature control can bring to many plants where these elements are a real issue.



The Fulton Sylphon Company with long experience in solving the temperature control problems of industry will be glad to send an engineer to make a survey of the possibilities for temperature control in your plant. His services are free. Write for Bulletin XB-125.

FULTON SYLPHON CO. KNOXVILLE, TENN., U.S.A.

McDanel Refractory Pyrometer Tubes and Protection Tubes

Years of experience in the refractory porcelain business plus a large number of tests of actual operation assure you that McDanel Products are right in every respect. In these tests, McDanel Tubes have proven to be far superior to various other makes. It will pay all pyrometer users to specify McDanel Tubes with their instruments or next replacement order from their instrument makers.

We have also developed a very successful combustion tube for carbon determination which has met with marked success.

McDanel Refractory Porcelain Co.
Beaver Falls, Pa.

Write for complete information on McDanel Products.

HWW HY-PRESSURE WELDED

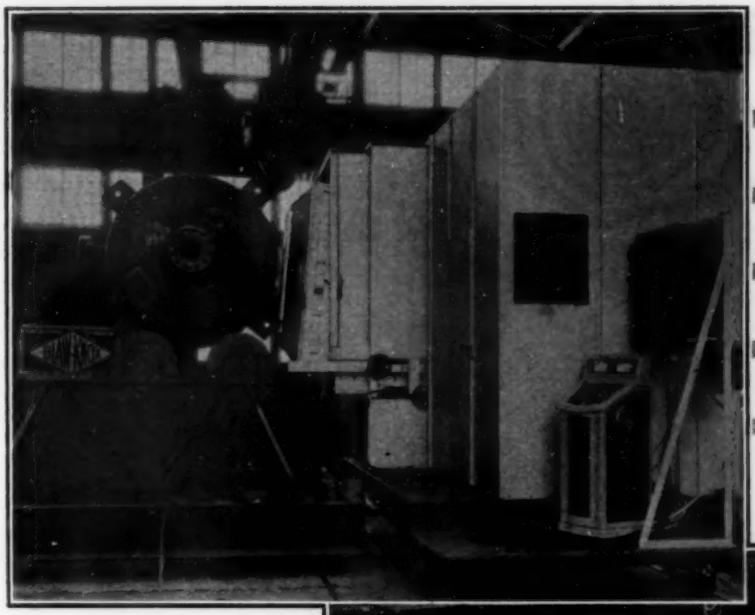
AUTOCLAVE

THE

HEDGES-WALSH-WEIDNER

COMPANY

NEW YORK CHATTANOOGA, TENN. CHICAGO



X-Ray machine used in examination of welds in Blaw-Knox shops

X-RAY PROVES DUCTILWELDS FLAWLESS

Group of Blaw-Knox Ductilwelded Boiler Drums built in accordance with the A. S. M. E. Code for power boilers

Scientific application of the "X" Ray in the Blaw-Knox shops acts as an additional safeguard for the purchaser of welded pressure vessels. Through the use of this equipment the welds can be literally explored inch by inch for density and complete fusion.

The Blaw-Knox Company has developed processes for welding carbon and alloy steels in which the tensile strength, ductility, resistance to corrosion and fatigue resistance is equal to or greater than the original metal. Blaw-Knox pressure vessels and other equipment for the process industries are standard equipment for many companies whose names and products are of international importance. Complete shop facilities, ultra-modern practice and a group of engineering specialists form the nucleus of a highly specialized division of the Blaw-Knox organization. This is ready to give you the following service:

1. Design and Engineering Cooperation
2. Manufacture to meet specification
3. Guaranteed workmanship

A new catalog entitled Blaw-Knox Ductilwelding of Carbon and Alloy Steels is ready for distribution. May we send you a copy?

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TRADE MARK BLAW-KNOX REG. U.S. PAT. OFFICE

WELDED CARBON & ALLOY STEEL EQUIPMENT FOR THE PROCESS INDUSTRIES

"How do we like the G-E Welders?

Six of seven G-E welders in a mid-western oil company, supplied by the Machinery and Welder Corp., Chicago, Ill.—a G-E welding distributor

FINE!

They're just right"

THAT was the unanimous opinion of the operators at a large mid-western oil refinery who are using seven of these G-E 400-ampere arc welders for all types of general maintenance and production work.

If you are skeptical, why not go to your welding distributor or nearest G-E office and see the new G-E welder in action? Test it yourself; compare it with any other welder on the market. See also the complete line of G-E welding electrodes and accessories. General Electric Company, Schenectady, New York.

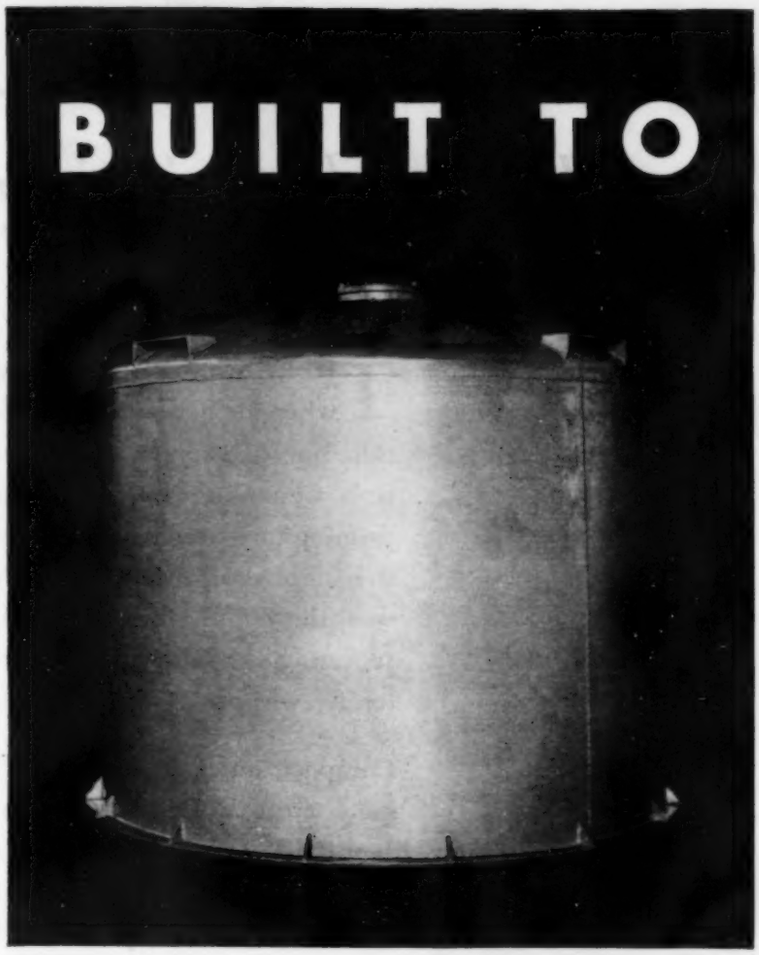
THE G-E ARC WELDER

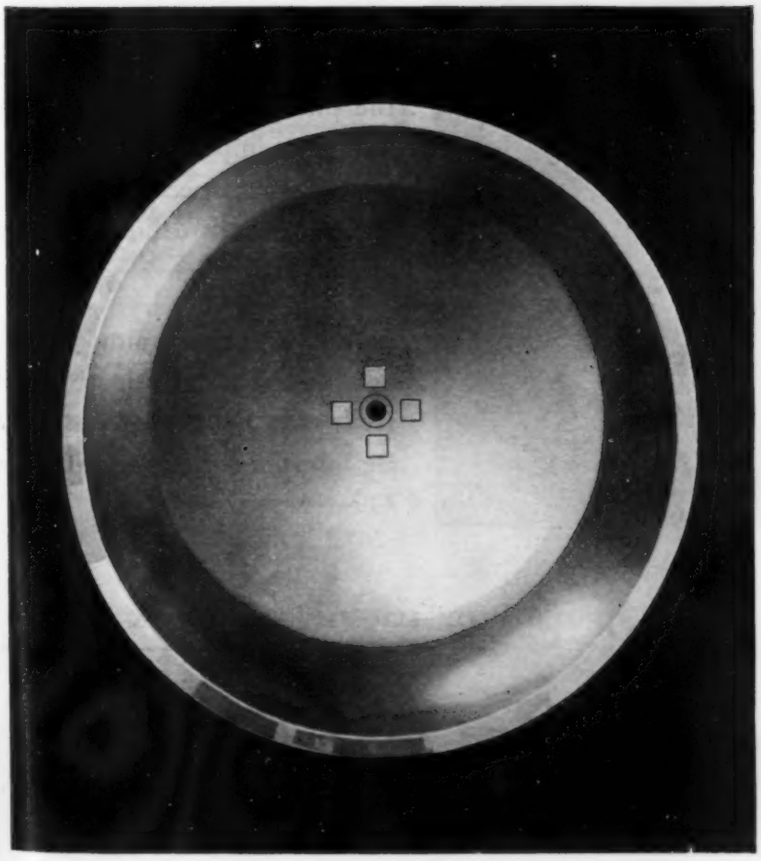
Combines and excels all the best features of all the good welders now on the market ... plus new features all its own.

1. **Stable, flexible arc**
2. **Quick recovery ("pep")**
3. **Self-excitation**
4. **Spark-free commutation**
5. **Simple operation**
6. **Duplex voltage control**
7. **Dead-front control panel**
8. **Large, protected instruments**
9. **Light, compact, strong construction**
10. **Low center of gravity**
11. **A definite purpose for every ounce of material**

530-133

GENERAL ELECTRIC





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FROM METALS OF YOUR CHOICE

WHEN you need special purpose tanks, or other process equipment made from carbon steel, chrome iron, pure nickel, chrome nickel alloys, nickel clad steel, or other alloys, draw upon Edge Moor's extensive experience in the fabrication of such equipment.

The use of alloy steels is rapidly increasing in many industries, such as food, beverage and light and heavy chemicals. Edge Moor specializes in the fabrication of equipment for such industries. An example of this service is illustrated in the photographs at the left. These pictures show the inside and outside views of a nickel clad steel tank of all-welded construction for a well-known food plant.

Send your blue prints and specifications for estimates.

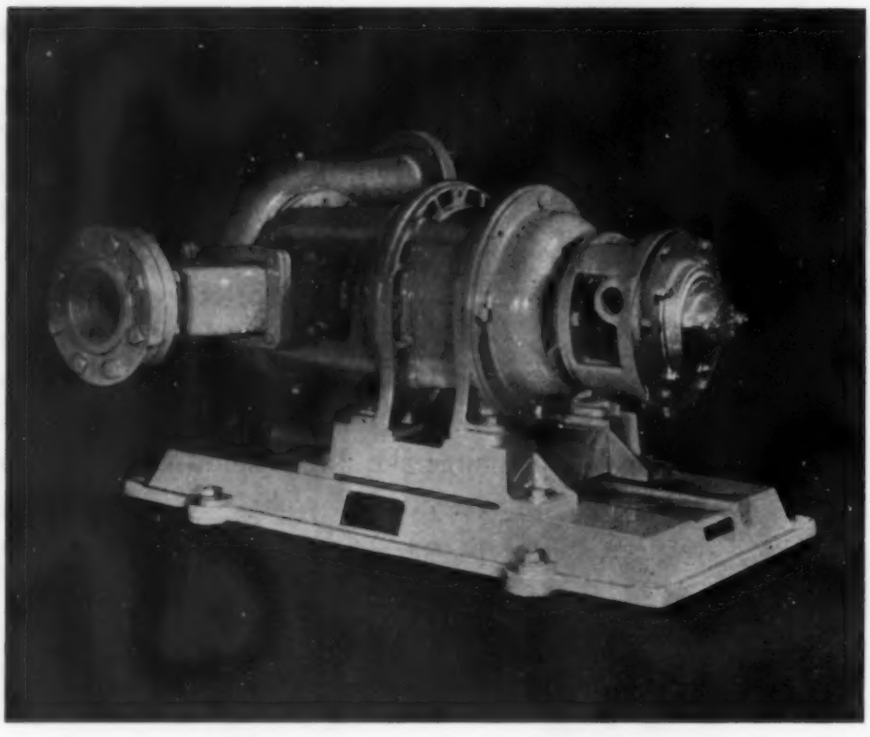
EDGE MOOR IRON CO.

ALLOY EQUIPMENT DEPT.
EDGE MOOR, DELAWARE

THIS *Suction* CENTRIFUGAL
. . . is more than self-priming

THERE is no loss of prime when air gets into the suction line of the Jennings Suction Centrifugal. A built-in priming unit permits this pump to handle air or gas *continuously* with the liquid being pumped. It can be operated intermittently without a foot valve.

Jennings Suction Centrifugals are furnished in standard sizes with capacities up to 2000 g. p. m. Heads up to 300 ft.

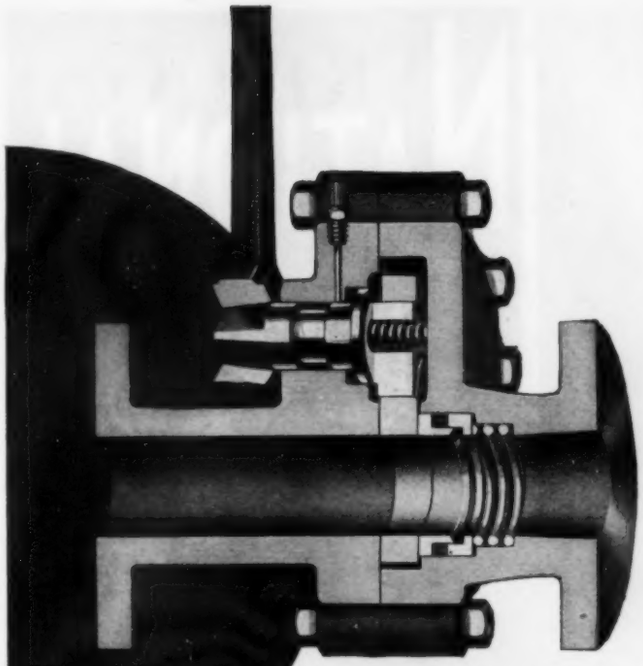


Compact, quickly installed and easy to take care of, the Jennings Suction Centrifugal is an ideal pump for chemical plant service. Motor, impeller and priming unit are mounted on one shaft, permanently aligned. There are no bearings in the pump casing. The interior of the pump is readily accessible and the impeller can be removed for inspecting or cleaning without disturbing packing or shaft alignment.

Wherever self-priming pumps are required, reliable trouble-free performance can be assured by installing Jennings Suction Centrifugals.

NASH ENGINEERING COMPANY, 31 WILSON ROAD, SOUTH NORWALK, CONN.

Jennings Pumps



THE QUICK OPENING VALVE OF LOW MAINTENANCE COST

THERE are nine good reasons why Yarway Pretite Valves are used by such firms as the Champion Fibre Co., du Pont Rayon Co., Endicott Johnson Corp., U. S. Aluminum Co., Procter & Gamble Co., American Cyanamid Co., and many others. They are:

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- **Second:** Straight through, non-clogging flow.
- **Third:** One piece solid disc with seating surface on both sides, protected from corrosion or erosion.
- **Fourth:** Unique Pretite feature which employs a sealing bushing on inlet side of the disc, hence double-tightening.
- **Fifth:** Disc in contact with its two seats through entire opening and closing cycle.
- **Sixth:** Sealing bushing is pressure-and-spring-packed.
- **Seventh:** Alemite lubrication for ease of operation.
- **Eighth:** Valves built of special metals to suit the particular condition of service.
- **Ninth:** Moderate cost.

Investigate Yarway Pretite Valves as a possibility for speeding production and cutting costs in your plant. Send for Bulletin P-501.

YARNALL-WARING COMPANY
7700 Devon Street Philadelphia

YARWAY
PRETITE VALVES

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for laboratory and test purposes

SPECIAL ADJUSTABLE PORTABLE TURBO-MIXERS

MANY of the Turbo-Equipment installations now in service grew out of tests made by our customers in their own laboratories or plants with Turbo-Equipment designed for that purpose.

TURBO-MIXERS for laboratory or test purposes are available in 2, 7 and 10 gallon sizes. The smallest of these has a glass jar. The others can be supplied in any metal, with or without jackets for use with or without pressure.

ALL models are adjustable for speed, position or agitating element, number and type of rotors, such as Turbo-Impellers with curved-blade deflecting rings, open impellers, propellers, paddles, aerating devices or other designs.

A Turbo Mixing Unit, consisting of a Duplex Impeller and CURVED (Patented) Deflecting Blade Ring, is shown below.

TURBO-EQUIPMENT for mixing liquids with other liquids, solids or gases is achieving otherwise unobtainable economies in many process industries.

DESCRIPTION and quotations on request.

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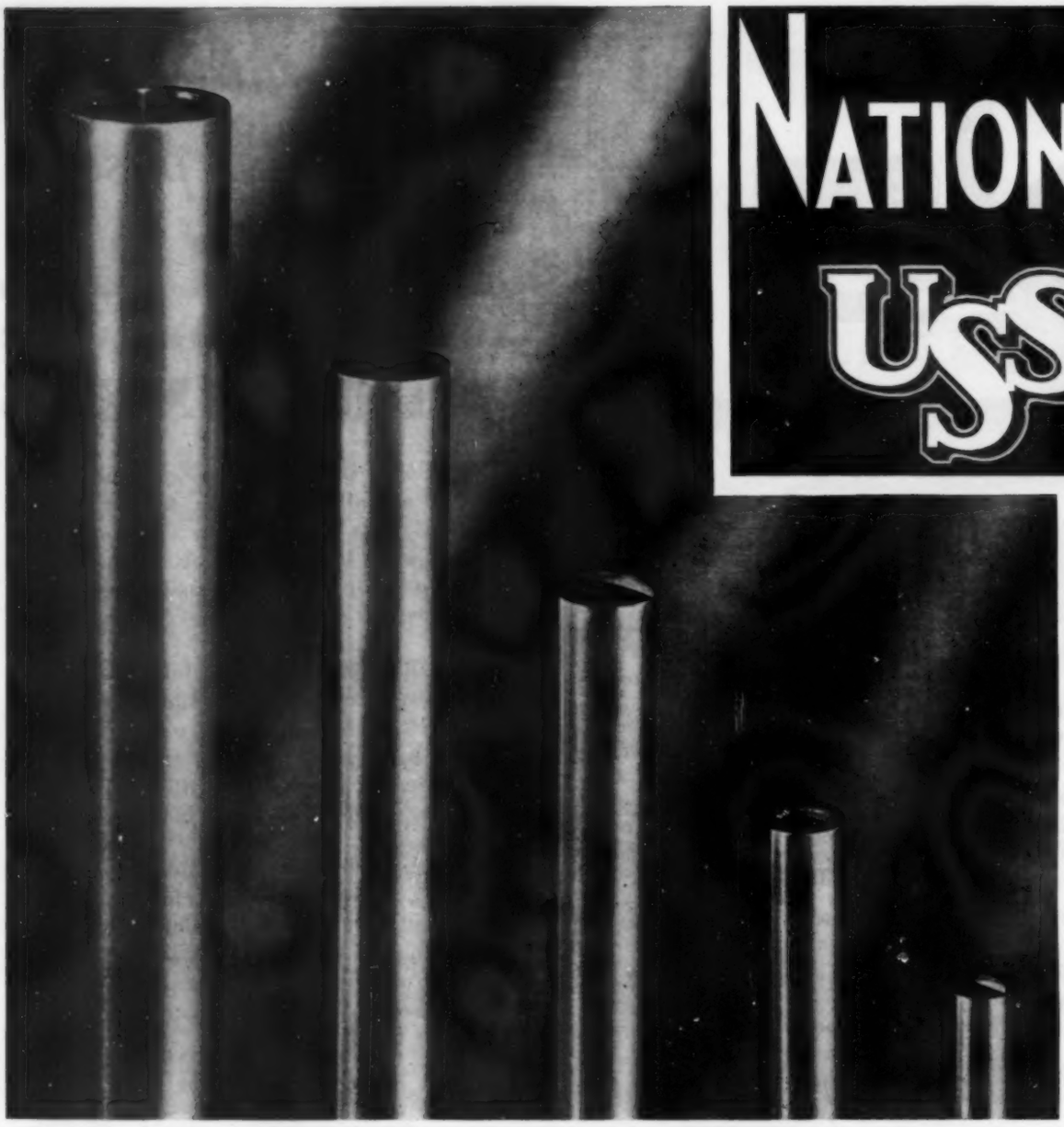

STAINLESS AND HEAT RESISTING PIPE AND TUBES

U S S Chromium-Nickel Alloy Steels are produced under the licenses of the Chemical Foundation, Inc., New York; and Fried. Krupp A. G. of Germany.

For certain uses of the Paper Field, tubing materials of quite special properties are required. High resistance to corrosion and protection against certain acids are indispensable; but they must be secured in combination with other qualities found only in high-grade steels. NATIONAL U S S Stainless and Heat Resisting Pipe and Tubes have been developed to meet such needs. They are now available with variations of character corresponding to formulas that long research has proved most useful. Specifically, U S S 18-8 (18% Chromium, 8% Nickel) and also U S S 17 (16% to 20% Chromium) and U S S 12 (11% to 14% Chromium) are recommended to the Paper Industry. No one formula is equally adapted for all purposes. Discriminating choice leads to maximum satisfaction. In any case of doubt, NATIONAL engineers and technicians will gladly assist in determining the best applications. Correspondence is invited. Ask for informative booklet, "NATIONAL U S S Stainless and Heat Resisting Pipe and Tubes".

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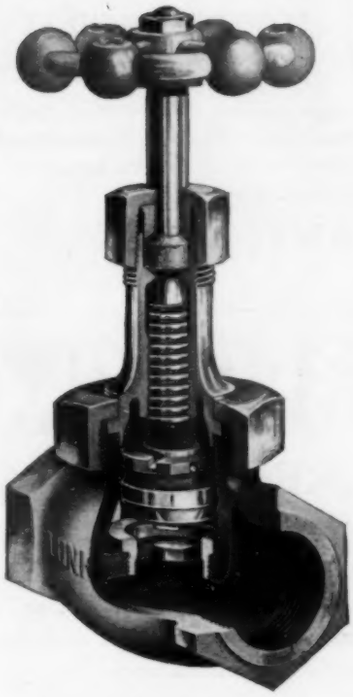

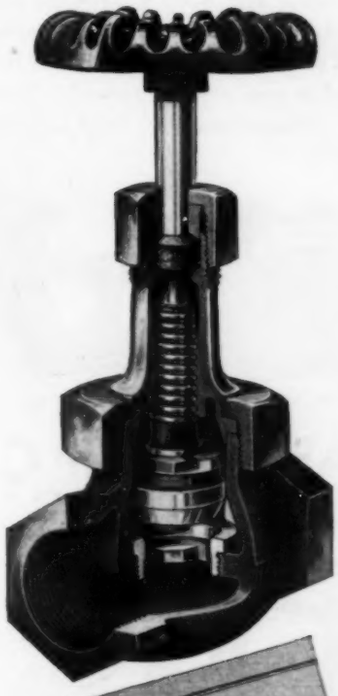

Descriptive booklet F-541 sent on request.

Fig. 1021 "Ferrenewo" and Fig. 73 "Renewo" VALVES

Quality products in every respect, these original Lunkenheimer designs effect extensive reductions in maintenance expense. Seats and discs are renewable and regrindable, and all parts of the two valves excepting bonnet rings are interchangeable. A single stock of repair parts is sufficient for both patterns, the 150 lb. W. S. P. "Ferrenewo" and the 200 lb. W. S. P. "Renewo".

Correct design and care in manufacture, together with rigid test and inspection, assure valves of unvarying quality.

Bronze "Renewo" Valves are also made in the outside screw pattern with either screwed or bolted bonnet, for steam pressures up to 300 pounds.

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Made in all sizes from 1/50 H.P. to 20 H.P. Clamps to any container.

Please specify

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DURABILITY — RELIABILITY

CARRIED *in* STOCK

Through the interchange of impellers Taber standard single suction Centrifugal Pumps serve also as custom-made pumps . . . and shipment is made from stock.

Whether you need a standard or a special pump . . . send your inquiry to Taber to know how well and how quickly you can be served. Write for comprehensive Bulletin No. G-631.

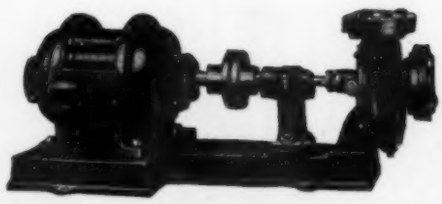

Fig. 190-A. Taber Single Suction Centrifugal Pump

TABER PUMP Co

ESTABLISHED 1859

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CENTRIFUGAL PUMPS

For handling pulp, slurry, sludge, sand, chemicals, and all other semi-solid, abrasive and corrosive materials. Also clear-water pumps for boiler feed, fire protection, water supply, and general service, for all capacities, heads, and methods of drive.

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Hackney has specialized on deep drawn seamless containers for 30 years—knows how to make them correctly.

In the department, partially shown above, huge presses draw the shells—correctly. In the furnaces, partially shown below, the drawn shells are heat treated—correctly.

A specially built shape—formed of one continuous piece of steel.

The result is, seamless metal tanks, barrels, cylinders, special shapes, that resist abuse, give longer service and mean lower annual cost.

Hackney can solve unusually difficult forming problems, in a wide range of metals. If your company uses metal containers—write for the details—today.

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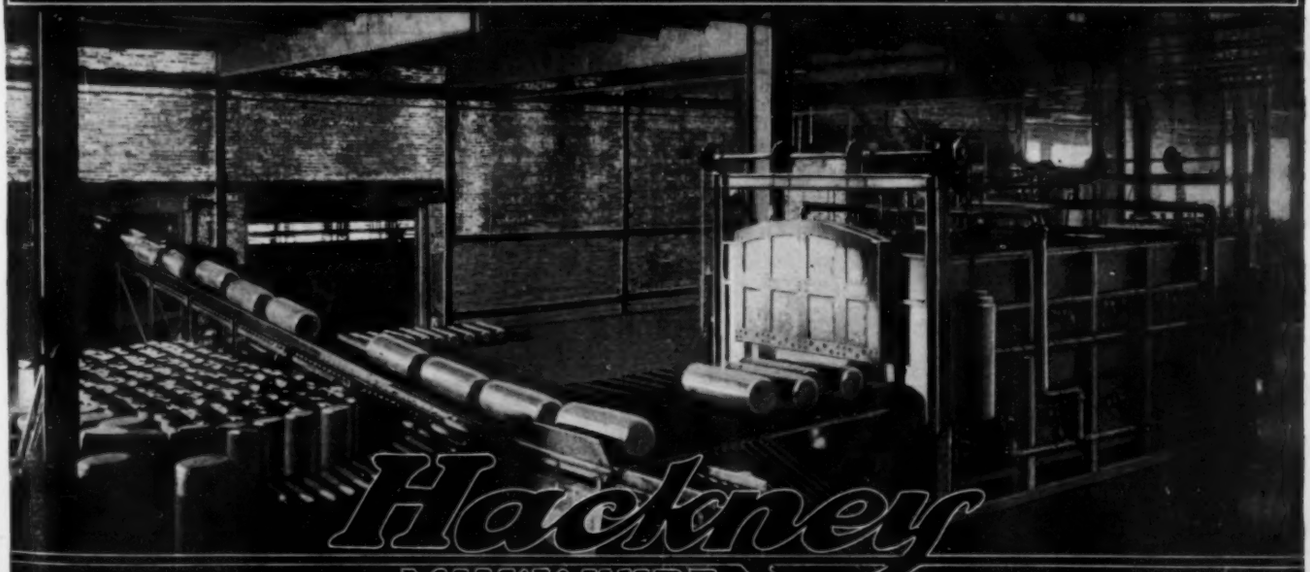


CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

MIXERS and SIFTERS That Insure CONSTANT UNIFORMITY

VERTICAL LIQUID MIXER

UNIQUE Mixing and Sifting Equipment insures that constant uniformity and high quality of product so essential to the retention and growth of sales. Only by the continued demand for your product can you hope to earn the profit you are desirous of showing and there is nothing that loses prestige and sales so quickly as impaired quality and uniformity.

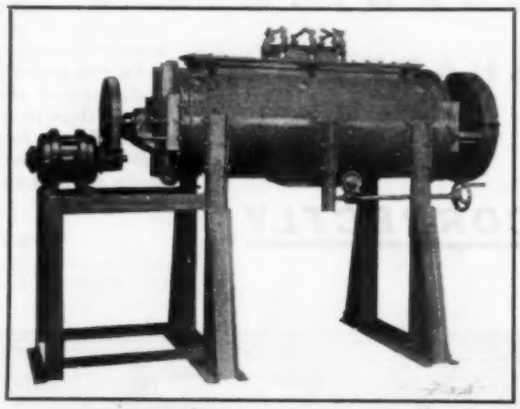
Why not let Robinson "UNIQUE" Engineers show you a "workable" mixer and sifter installation? More than 30 years of experience in problems of crushing, grinding, pulverizing, sifting, mixing, elevating and conveying go into their recommendations, and you may gamble on it that by following the plan they outline, you will enjoy the utmost in highest quality and economical, efficient production.

MIXERS

UNIQUE and GARDNER Mixers answer every problem of mixing dry, damp, liquid, free-flowing or sluggish materials. We are constantly making installations for the mixing of all types of products—recommending and furnishing standard machines where they fill the bill—but often designing and building special mixers where standard types have failed to produce the desired results.

Left: VERTICAL LIQUID MIXER —GLASS LINED—with dished bottom—built for mixing a special product. We build an extensive line of liquid mixers for dissolving cellulose products and for preparing softeners, emulsions, size mixings, finishing mixings, pastes, soaps, paints, shoe dressings, greases, rubber solutions and cements, etc.

Right: A special Horizontal Mixer with full cylindrical body, with manhole on top, for handling an internal pressure; and with an external jacket carrying high or low pressure steam. Other desirable features include roller bearings, cut gear drive from motor, heavy welded steel frame carrying both mixer and motor, and a special worm gear discharge mechanism. These are typical examples of designing special mixers to meet individual needs.



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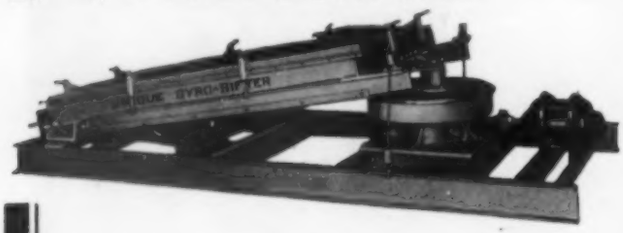
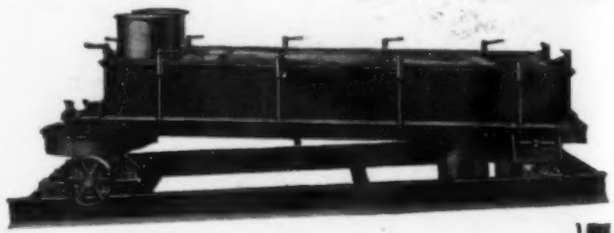
For production sifting, separating and grading all types of materials where absolute uniformity of "size" and economical operation are paramount requisites. Gyro-Sifters and other UNIQUE Sifters are in successful operation in hundreds of plants handling light and fluffy or heavy and dense materials with equal dexterity.

Two views of specially built Gyro-Sifters arranged for handling special, unusual products. Desired variations may be made for handling YOUR product.





Write us today for literature on UNIQUE Mixers and Sifters—and for information that will solve your problems.

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Complete Process Equipment—PLUS—A Helpful Engineering and Advisory Service

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Some PLAIN TALK about Filtration from the Executive's Viewpoint...

Low Cost of Operation is Imperative

What interests a managing executive about new equipment is what it will accomplish that his present equipment can not and at how much lower operating cost.

That holds for filtration. If your present method is efficient, economical and inexpensive, it would be folly to consider new filtering devices just to be MODERN. But if it can be shown that the new will replace the old with profit to you, it is time you investigated. For in these days of low commodity prices, every last cent of economy should be realized in machine operation.

In considering the possibilities of improving the filtration or clarification process in your plant, we suggest that you look for honest answers to these questions:

1. Is your existing filtering equipment giving the best possible quality of product?
2. Is the labor chargeable to the operation low?
3. Are the design and construction of your equipment such as to make easy operation possible?
4. Is the filter low in Maintenance, Repair and Power costs?
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The Shriver organization has been building filter presses for hundreds of applications in the chemical, metallurgical, food products and kindred industries for over thirty years. Its abundance of experience in solving many difficult individual problems in filtration has given it a progressive technical and economic outlook on the plant requirements of today.

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10 Horse Power Century Type SC Squirrel Cage Induction 3-phase Motor

"They Keep a-Running"

WHEREVER THERE'S DAMPNESS

In many installations where more or less dampness and moisture are always present, Century Type SC Squirrel Cage Motors are daily proving their service continuity . . . The windings are thoroughly insulated and are then saturated with insulating varnish. This preserves the insulation, protects the windings and assures the dependable operation necessary in Pumps, Compressors, Refrigerators and similar installations exposed to moisture and dampness . . . Furnished with either ring-oil phosphor bronze sleeve bearings or grease-lubricated ball bearings.

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Specify "HARRISBURG"

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SPECIAL-PURPOSE CHEMICAL EQUIPMENT

Experienced Designers of Chemical Equipment "Harrisburg" maintains a staff of engineers with a wealth of experience in the designing of chemical equipment. When you have requirements for special-purpose equipment, call in our nearest representative or send along your rough ideas to our Harrisburg office. Our engineers will gladly work up designs.

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Makers of Its Own Alloy Steels for Special Uses "Harrisburg" makes its own alloy steels and is thus able to furnish, complete, special-purpose equipment requiring steels of special contents. This complete manufacturing control assures accuracy as well as lower costs to you.

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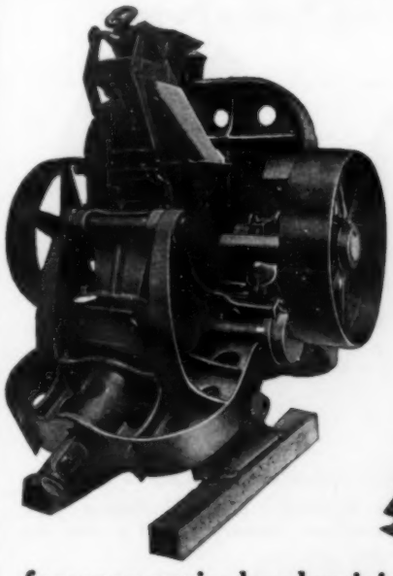
Maxecon Mill



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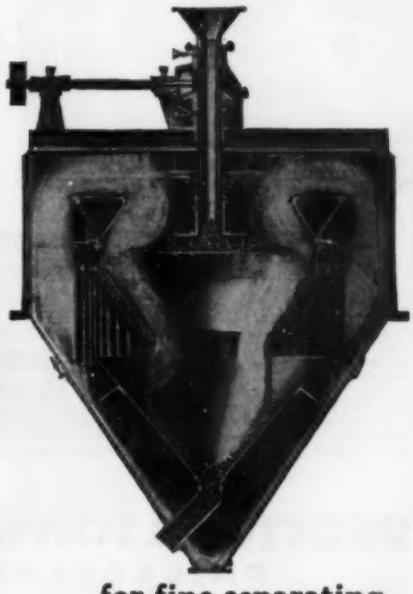

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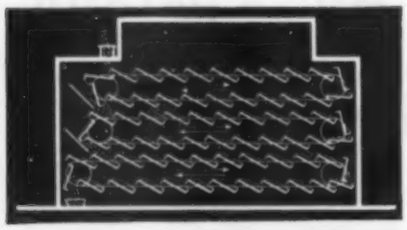
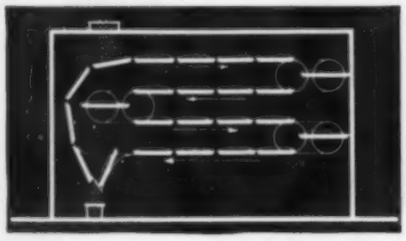


Proctor Continuous Dryer—Reversing Pan Type, for granular and loose materials. Compact nested trays which turn over at ends of runs dumping contents into trays in next lower run exposing fresh surfaces, speeding drying, insuring uniformity.



Proctor Continuous Dryer — Non-Tilting Pan Type, for materials that must remain undisturbed thru the drying process. The trays travel in runs from top to bottom always in a horizontal position. Adaptable to processes other than drying, too.

PROCTOR & SCHWARTZ, INC
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For ugly loads

The MARION DOLLY TRUCK handles the awkward, bulky, heavy, hard-to-get-hold-of loads—cases, barrels, rolls, bundles, drums, carboys. It cradles the load, carries it swiftly, in perfect balance. Low skids permit loading from either side or either end. Built in seven sizes—high wheel and low wheel types—flat top and cradle top styles.

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MARION MALLEABLE IRON WORKS
922 Miller Ave. Marion, Indiana

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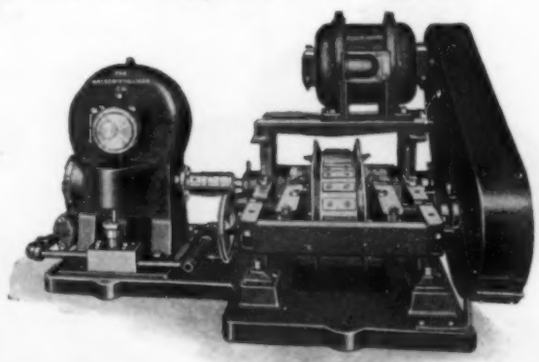
WATSON-STILLMAN PUMPS

For All High Pressure Purposes



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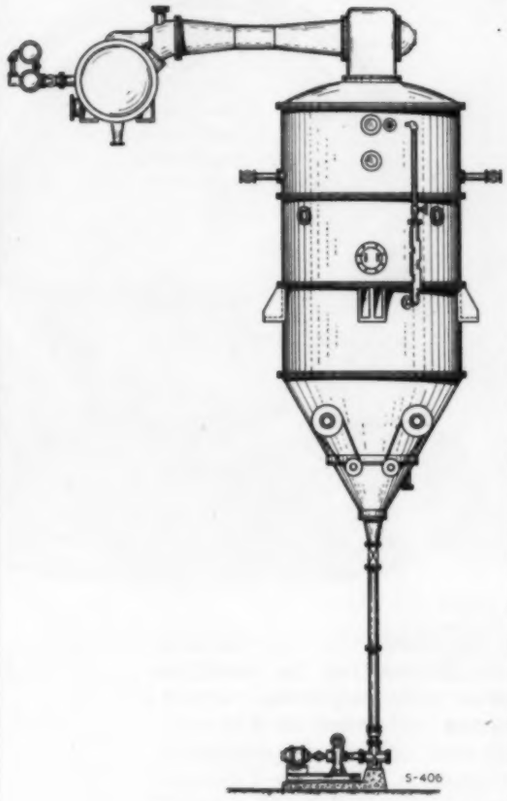
Write for Catalog

THE WATSON-STILLMAN CO.
112 Aldene Road, Roselle, N. J.

Announcing the

CONTINUOUS Vacuum Crystallizer



VACUUM CRYSTALLIZER

CONTINUOUS OPERATION . . . Continuous operation is now added to the many advantages of the Vacuum Crystallizer. The Swenson design eliminates troublesome salting and provides effective insurance against short-circuiting at the higher vacuums.

SINGLE STAGE MULTI-STAGE OR BATCH . . . For large problems, multi-stage operation will improve the economy. Low temperatures may be reached and if desirable, cooling water 20 or 30 degrees higher than the temperature to which you wish to cool may be used by the equipment.

HANDLE CORROSIVE LIQUORS . . . For corrosive liquors this equipment readily lends itself to fabrication from acid-proof materials.

UNIFORM SATISFACTORY PRODUCT . . . Evaporation is a cooling process — this equipment effectively utilizes this fact to remove heat from the liquid. Placing the liquid to be cooled under a vacuum high enough to induce boiling, rapidly reduces the temperature. The Swenson design controls this operation and gives continuous results and a uniform crystal product easily handled on the rotary vacuum filter or centrifugal.

USES . . . For large capacities at corrosive conditions, the Vacuum Crystallizer will show large investment savings over any other type of equipment available.

OTHER TYPES . . . Every crystallization problem can be solved by Swenson's complete line of crystallizing equipment, including the crystallizing evaporator, the Swenson-Walker continuous crystallizer, batch type crystallizers, etc.

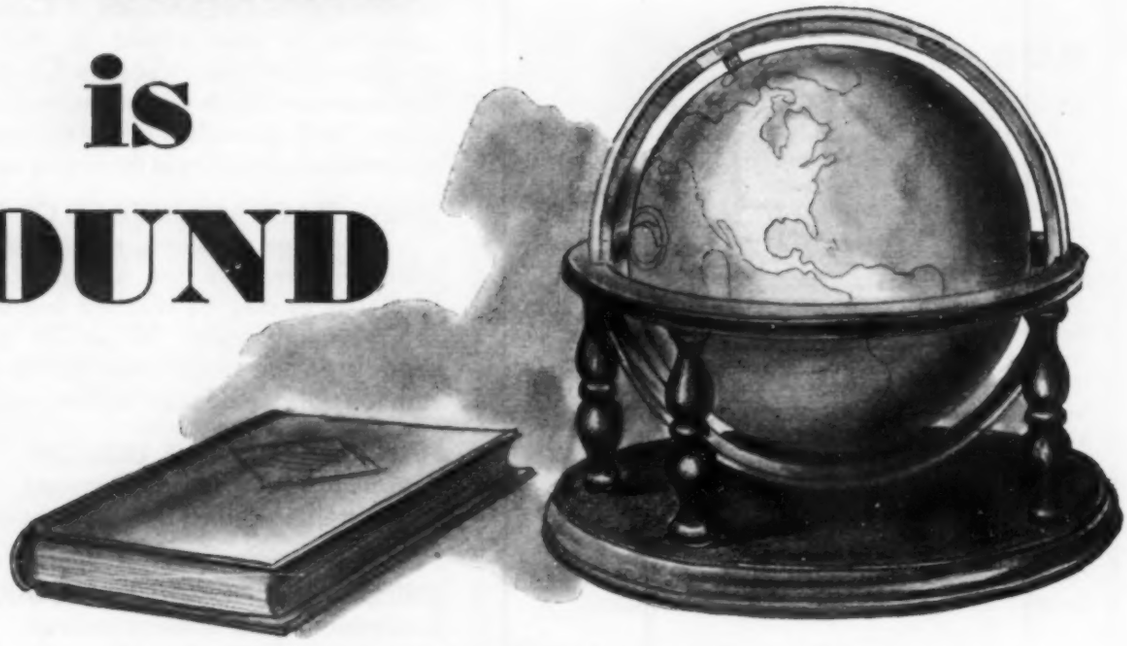
Further information on request.

SWENSON EVAPORATOR CO.
(SUBSIDIARY OF WHITING CORPORATION)
15669 LATHROP AVE., HARVEY, ILL. (CHICAGO SUBURB)

SWENSON

ALL TYPES of EVAPORATORS FOR EVERY USE

The WORLD is ROUND



It took man a long time to become convinced that the world is round. But now, virtually everyone knows that the world *is* round. ¶ But it did not take pyrometer users long to find out the facts about Chromel-Alumel couples and leads when they became available about 25 years ago. And now, almost all pyrometer users accept these products without question. They like Chromel couples, because they can be used up to high-speed steel temperatures; that the couples can be welded at the cold-end and thus give double service; that they don't have to be "packed" in the protection tube, which makes them more responsive; they like their accuracy and long life — and the fact that the lead wire is made of the same material as the couple itself which eliminates possible compensation errors. (There's nothing to "compensate"). These are the basic reasons why all the really big pyrometer installations are calibrated for Chromel-Alumel couples and leads. It pays to have your pyrometer maker calibrate your meters for these products — to make available for you all the accuracy that's in your meters. For technical data ask for Catalog -HT.

HOSKINS MANUFACTURING COMPANY
4435 Lawton Ave., Detroit, Mich.
In Canada: Walker Metal Products, Ltd., Walkerville, Ontario

HOSKINS Chromel Couples

Dorrco Doings in 1932

The mental confusion, caused by the events of the past year, is the outstanding feature of the present outlook of most of us. Many explanations have been offered for present conditions and many means have been advanced for overcoming them. These range all the way from the cancellation or reduction of all debts, both international and national, to Technocracy and its demonstration of the enormous and geometrically increasing growth of power per capita in the last hundred years and the great opportunity it offers if we can effect a proper distribution of the material benefits which may be had with a small amount of labor.

Pupin suggested last winter that, since the discovery of certain physical laws and their application had led to the enormous technical developments of our present civilization, we should now search just as diligently for some spiritual laws which would overcome the twin evils, Hate and Fear, which are the root of the world's present unhappiness and suffering. "Profits or Prosperity," the title of a recent most incisive analysis of present conditions, is in itself most thought provoking.

Does not the way out depend on our recognition of the real reason why we do things—to justify ourselves to ourselves—and on our realization that financial gain, which so many of us have thought to be the mainspring of our civilization, is only one of a number of means to such justification? The scientist already knows this and regards money only as a means to an end.

The really successful man is the one who values his accomplishments for himself or others as the real thing and accepts the financial returns as only valuable insofar as they supply his needs or serve as a recognition of his accomplishments. From this viewpoint, those of us who individually or corporately have held our heads above water may perhaps feel we have been more "successful" than we thought.

SANITARY ENGINEERING

The mechanization of this field has continued, with much development done in improving existing equipment and in meeting new demands.

The Sifeed Clarifier, in both square and round tanks and employing either traction drive or a drive supported on a central column, meets new demands with notable installed savings.

The Type K Digester, a new unit, is now equipped with a central supporting column and a self-contained drive unit, thus dispensing with the unsightly superstructure formerly used. We are planning to extend present sizes to diameters of 100 feet and possibly beyond.

The Dorrco Aerator, brought out as our sixth step in mechanization after several years experimental work, combines mechanical means of maintaining sludge in suspension with diffuser aeration. This materially reduces the total power required for activated sludge treatment and allows regulation of the air to meet changing conditions.

It is interesting to know that a similar problem in cyaniding gold ores was met some years ago by the Dorr Agitator which largely displaced both air and mechanical agitators for the same reasons.

The Dorrco Distributor, also a new type, has this year been developed for trickling filter treatment.

WATER PURIFICATION

Continuous sedimentation with Dorr equipment has long been standard in this art, both for the removal of silt and chemical precipitate. It has been merely an extension of our experience and viewpoint that has led to the development of a mechanical flocculator.

The Dorrco Flocculator was originally operated longitudinally, but, to meet special requirements at one plant where long coagulation basins were already installed, a further development, resulting in transverse operation, was made with the cooperation of the engineer in charge. At this plant, the flocculators brought about a maximum utilization of chemicals, making a saving of one grain of alum per gallon or $1,400 monthly in chemicals alone. Improvements made in the floc structure have saved much in filtering costs.

CLASSIFICATION

Continuous leadership in one field for twenty-five years can only be maintained by intensive work and the intelligent utilization of broad experience.

This year the *Critical Size Control* has materially improved bowl classifier operation while recent tests at one overloaded gold mill showed that our automatic *Closed Circuit Grinding Control*, continuously controlling the rake load, increased primary grinding capacity 15 per cent or more.

The Dorr FX Classifier has this year raised our 1928 peak of 3000 tons rake load per day to 12,000 tons—1000 tons of sand per foot of rake width. Operating in closed circuit with an 8'x12' ball mill it overflowed 7200 tons per day of 35 mesh product and increased the ball mill's capacity 30-40 per cent.

With the aid of type F Bowls in the secondary circuit, a 100 mesh product was made in this mill section at less cost than the former 65 mesh product and a 4 per cent greater copper extraction was secured.

AGITATION AND PULP REFINING

Among the new things undertaken this year are the Turbo Mixer, for high-speed, mechanical agitation, and the Wiener Refiner, used in the paper industry in place of jordan engines for refining stock. Both are justifying our expectations and proving valuable additions to our line.

DORR-OLIVER

Coordination has resulted in placing the European interests of both companies under unified management and in the use of joint offices and agencies elsewhere when possible.

ENGINEERING

Two plants for binding fixed nitrogen have been completed during the past year, and, as with all pioneer work, much has been learned and some tools developed that promise a wider application.

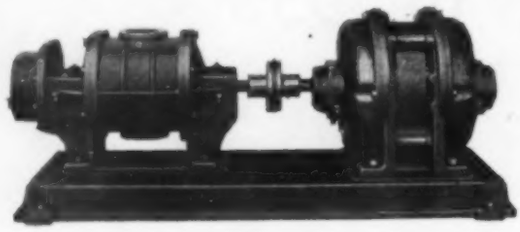
In common with the trend in capital goods production, the past year has been a difficult one for our company and we go into 1933 with reduced staff and incomes, but never has our faith been greater or our "will to do" less hesitant. For all of us, I give best wishes to friends scattered over the world and say, in the language of the Unemployment Relief Fund posters, "We will see it through."

John V. N. Dorr

247 Park Ave., New York

DORRCO

POSITIVE AERATION AND AGITATION



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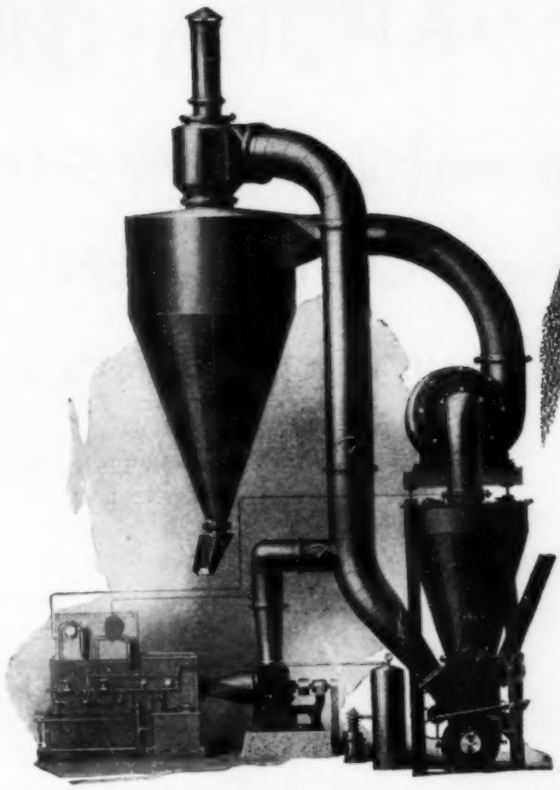

Raymond Air-Drying Pulverizer

The modern grinding un it that provides scientific control over drying and pulverizing. It evaporates moisture from the material and delivers a fine, dry product of uniform quality.

If you have a special problem in drying, pulverizing or dust collecting, just tell us your requirements—our 45 years' experience is at your service.

First Aid for hard jobs

HAVE you a difficult grinding operation?—that defies the ordinary methods?—or runs up your production costs?

Then you may be interested in the Raymond Air Drying Pulverizer—and what it can do for you on "hard to handle" materials.

This modern pulverizing unit operates on the principle of the Raymond Kiln Mill. It dries as it grinds, performing a complete process automatically and dustlessly:—

Feeds the material at properly controlled rate to maintain maximum mill capacity
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Removes the moisture by air-drying-in-the-mill
Classifies the powder to any desired fineness
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Conveys finished material to bin by air system.

Thermostatic controls govern the temperature of the circulating air and determine the rate of evaporation. This permits the grinding and drying of delicate products without injury or discoloration. It puts chemical grinding on a precision basis by giving positive control over the process.

You will find that the Air Drying Pulverizer is a valuable "first aid" for hard jobs in chemical manufacture. It offers new economies in grinding dry colors, dyestuffs, talc, drugs, chemical compounds and filter-press products.

Write for your copy of the NEW PROCESS BULLETIN which describes the latest methods of chemical grinding. RAYMOND BROS. IMPACT PULVERIZER CO., Main Office and Works, 1311 North Branch Street, Chicago; 342 Madison Avenue, New York; Subway Terminal Bldg., Los Angeles.

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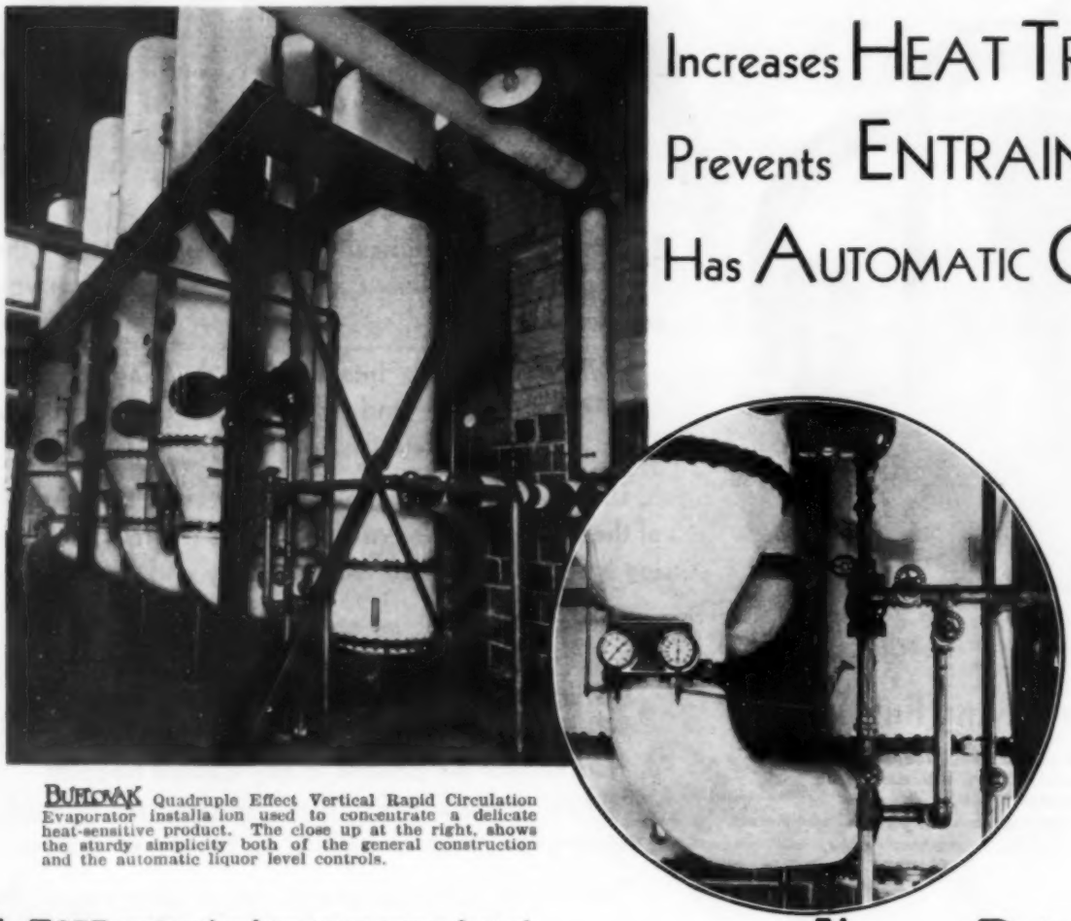
This NEW *VRC EVAPORATOR

Increases HEAT TRANSFER
Prevents ENTRAINMENT
Has AUTOMATIC CONTROLS



BUFFLOVAK Quadruple Effect Vertical Rapid Circulation Evaporator installa lon used to concentrate a delicate heat-sensitive product. The close up at the right, shows the sturdy simplicity both of the general construction and the automatic liquor level controls.

MORE evaporation from every square foot of heating surface has been strikingly accomplished in this recent BUFFLOVAK installation.

Here again, the design employs rapid circulation to increase the heat transfer—to do *more* and *better evaporation* in smaller units—with less floor space and to produce a better concentrated product from this heat sensitive material, because evaporation occurs so quickly.

The design is exclusively a BUFFLOVAK development. The steam chests and vapor bodies are separate units arranged to virtually eliminate entrainment. A unique arrangement causes a complete reversal in the directional flow of the vapor, allowing gravity to free any entrained water particles.

The operating advantages of this type evaporator have already been successfully applied to a wide variety of liquids ranging from black liquor to milk. This type is particularly well adapted for concentrating foamy liquids or those which ordinarily coat the heating tubes.

Bulletin 264 explains in detail the applications and operating results. Copy will be sent upon request.

*VRC = Vertical Rapid Circulation.

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How Much have You paid *for small wastes this year?*

$2000 A YEAR was the cost to one plant* of a seemingly unimportant inefficiency in handling methods. To another plant** the cost was $600. You may have paid as much or more during the year now ending. For in a year's time, small wastes that multiply with each handling of raw or fabricated material can make an astonishingly big total.

This is a good month in which to investigate your handling methods, and to take steps to turn small wastes into a profit for next year. How sizeable that extra profit can be... how it may more than equal the cost of a Shepard Electric Hoist to modernize handling, will be seen by reading the following typical examples of wastes which Shepard has saved.

Worthwhile Savings thru stopping small wastes

*1—"Our old method was to have the charge wheeled to the furnace, dumped and shoveled in by hand. It took 10 minutes—the Shepard Hoist takes but 1 minute and it saves $2000 a year."

**2—"In handling bags to our second floor, a Shepard Hoist saved $600 in a year... more than paying for it."

3—"The Shepard Hoist cuts loading time 50 percent and prevents a jam of trucks at the platform."

4—"Costs on one handling operation are $1100 a year less because we have the Shepard Hoist."

5—"Our Shepard Electric Hoist, used to lower carbonators into a tank for test, paid for itself in 6 months."

Only a Shepard has these features

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Electric Traveling Crane

Floor Control Electric Hoist

A Survey of Your Plant

Check up on your handling operations, now. Let one of our engineers with intimate knowledge of a wide variety of cost-cutting applications assist you in hunting out inefficiency. Call on our nearest office, and a capable man will be sent to you. Any help he may give will not obligate you.

Shepard Niles material handling equipment includes Electric Hoists, Mono-rail and Transfer Cranes, and Cupola Chargers. The range of sizes and types is incomparably complete, and our own lower production costs are reflected in our revised prices.

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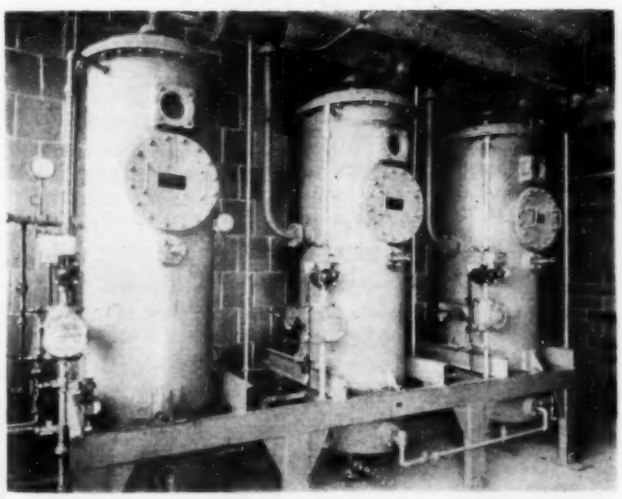

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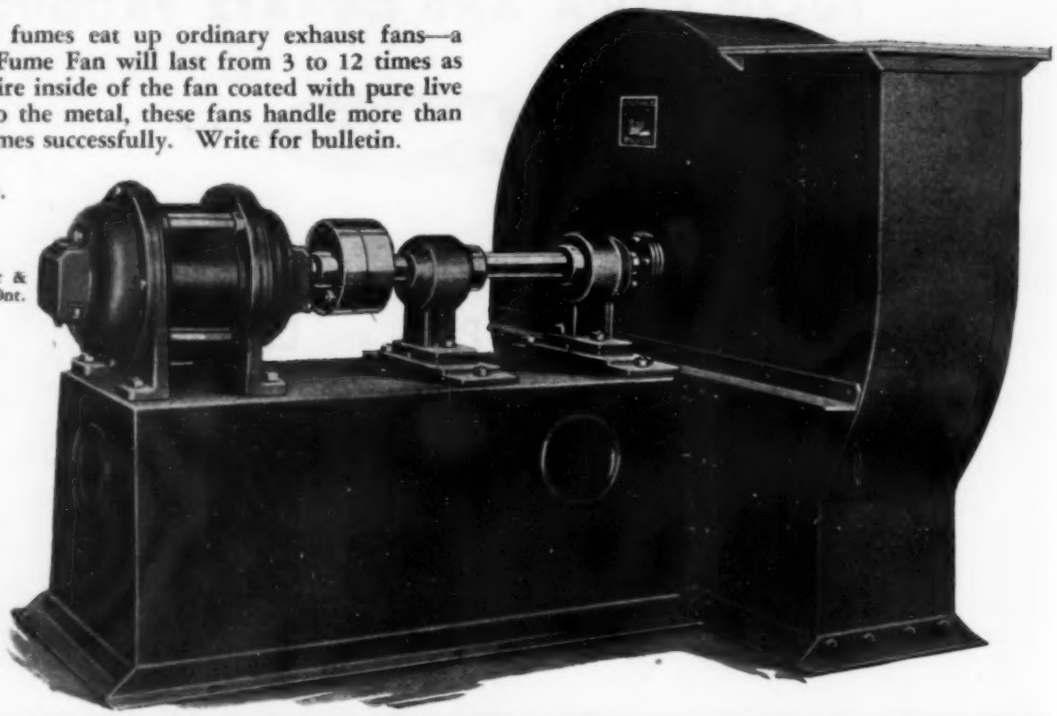

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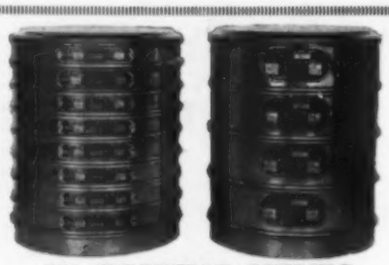

291 TESTING SIEVES

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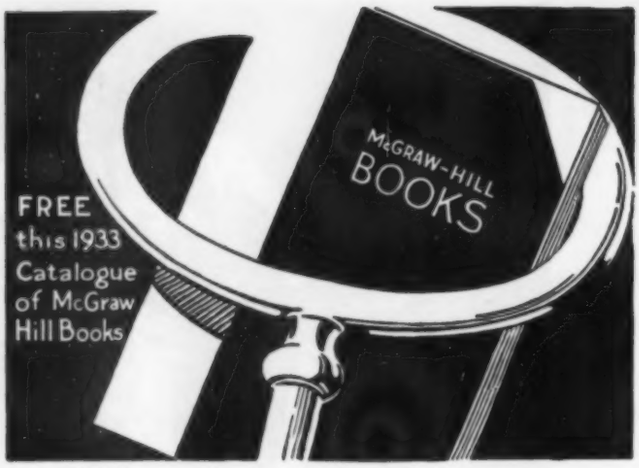

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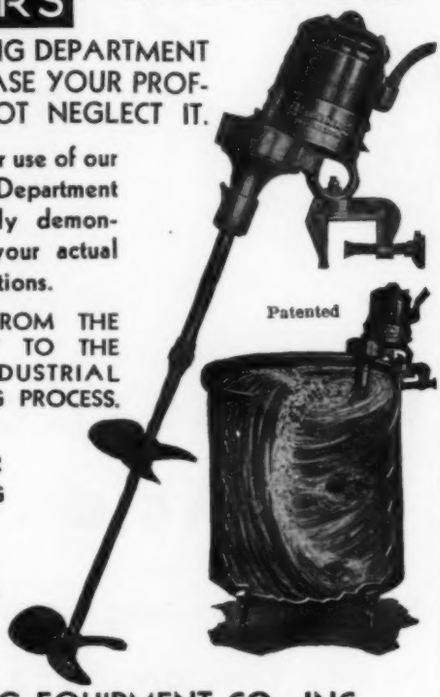

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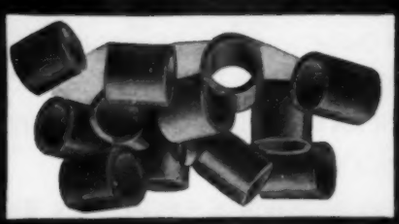

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½" x ½"	10,000	64	57	102
¾" x ¾"	3,000	47	68	72
1" x 1"	1,350	40	73	58
1¼" x 1¼"	665	45	70	44
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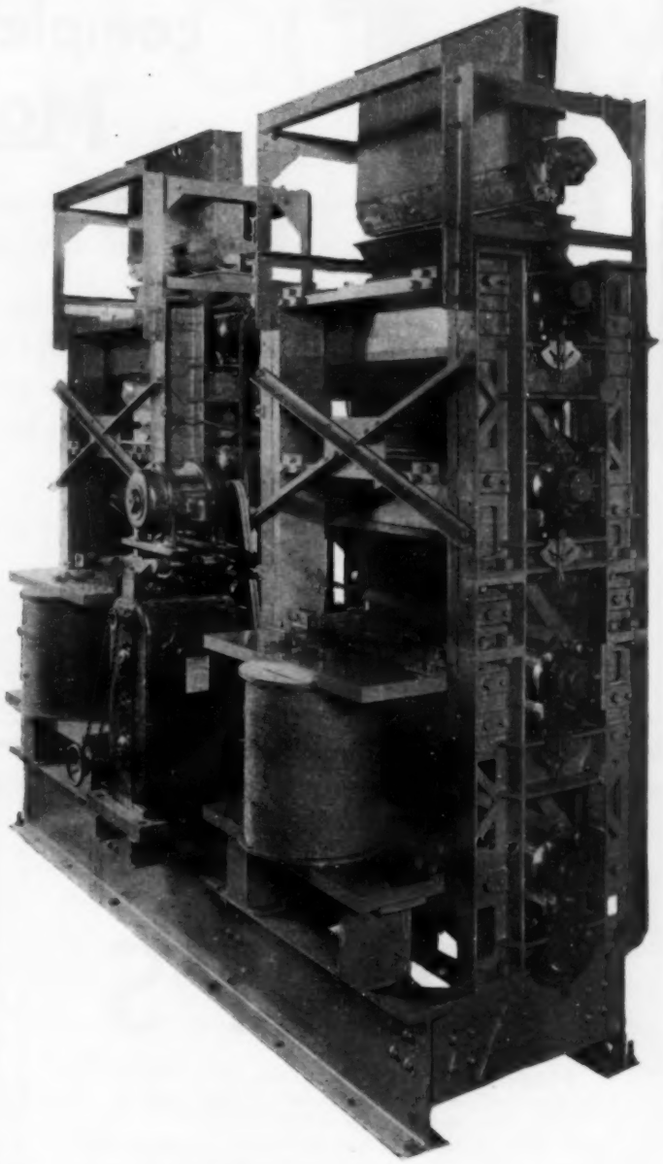

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*Please refer to Department of Commerce Information Circular 6488, page 12, dated June, 1931.

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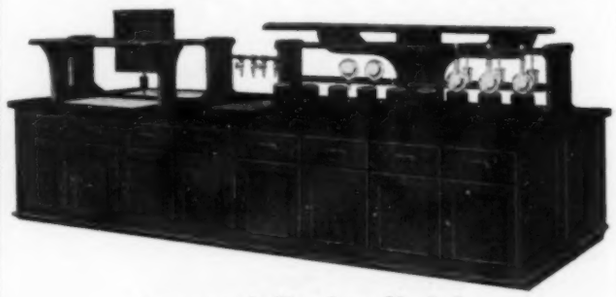

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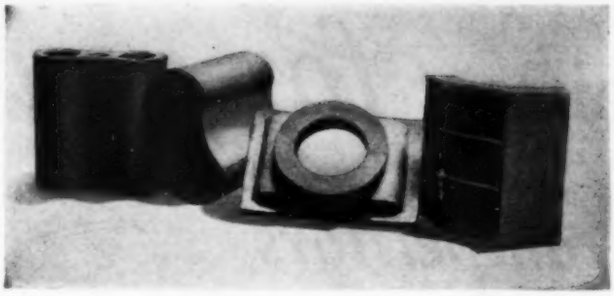

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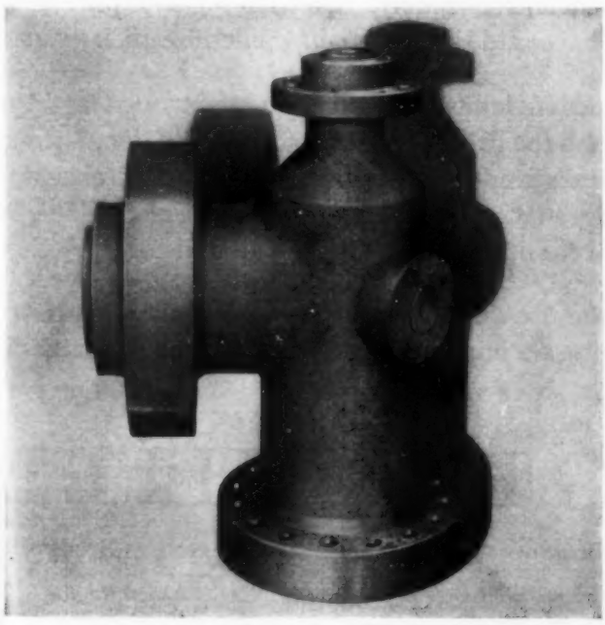

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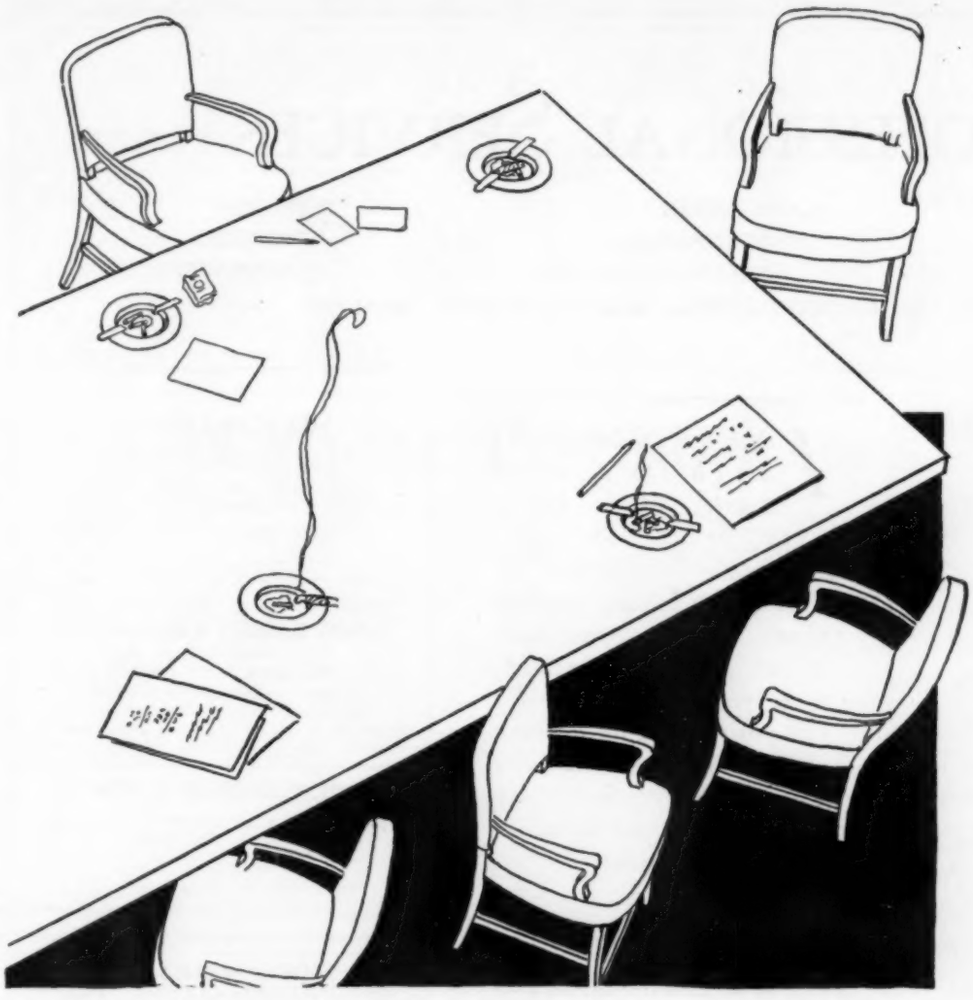

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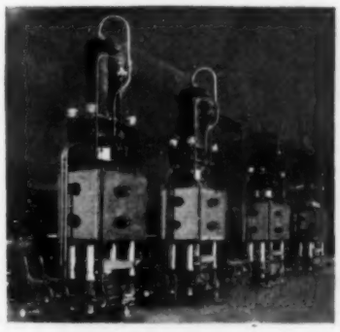

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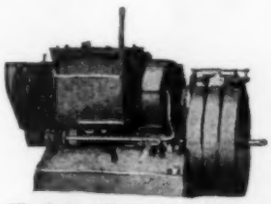

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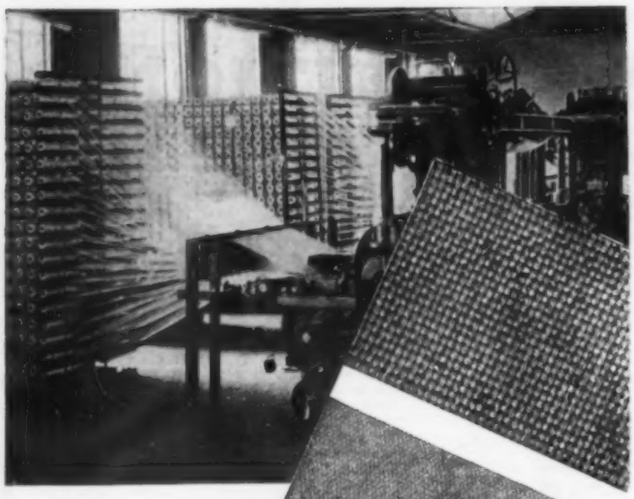

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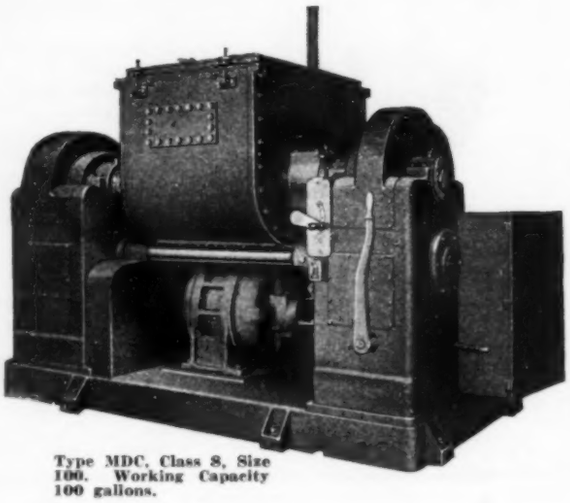

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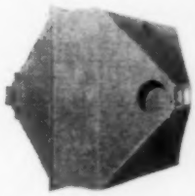
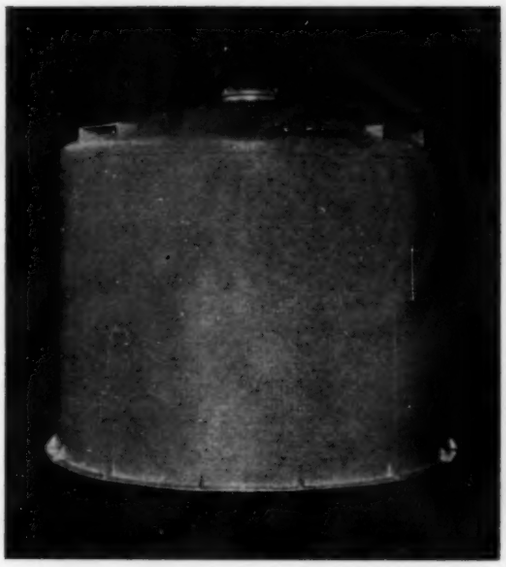
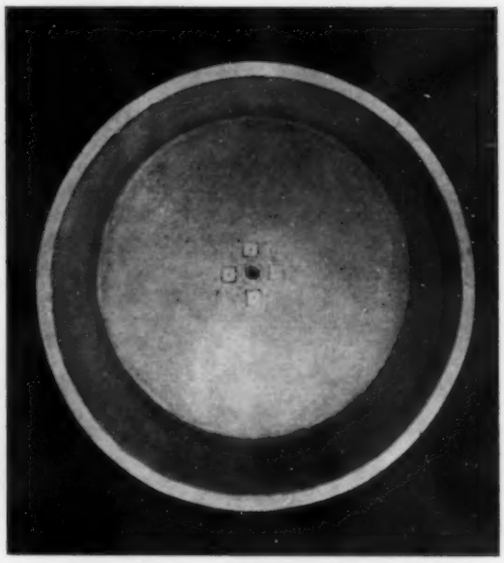


Special hopper also welded from Lukens Nickel-Clad Steel.

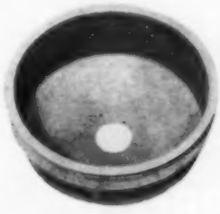


Tank, including the heads, fabricated by welding from Lukens Nickel-Clad Steel, by Edge Moor Iron Company.



Interior view, showing the pure, solid Nickel surface of Lukens Nickel-Clad Steel in the tank illustrated at the left.

Jacketed kettle used by a well-known rubber company in handling a strong brine solution. The inside kettle is Lukens Nickel-Clad Steel, $\frac{1}{4}$" thick, with 10% clad.



Welded hoppers fabricated from Lukens Nickel-Clad Steel.

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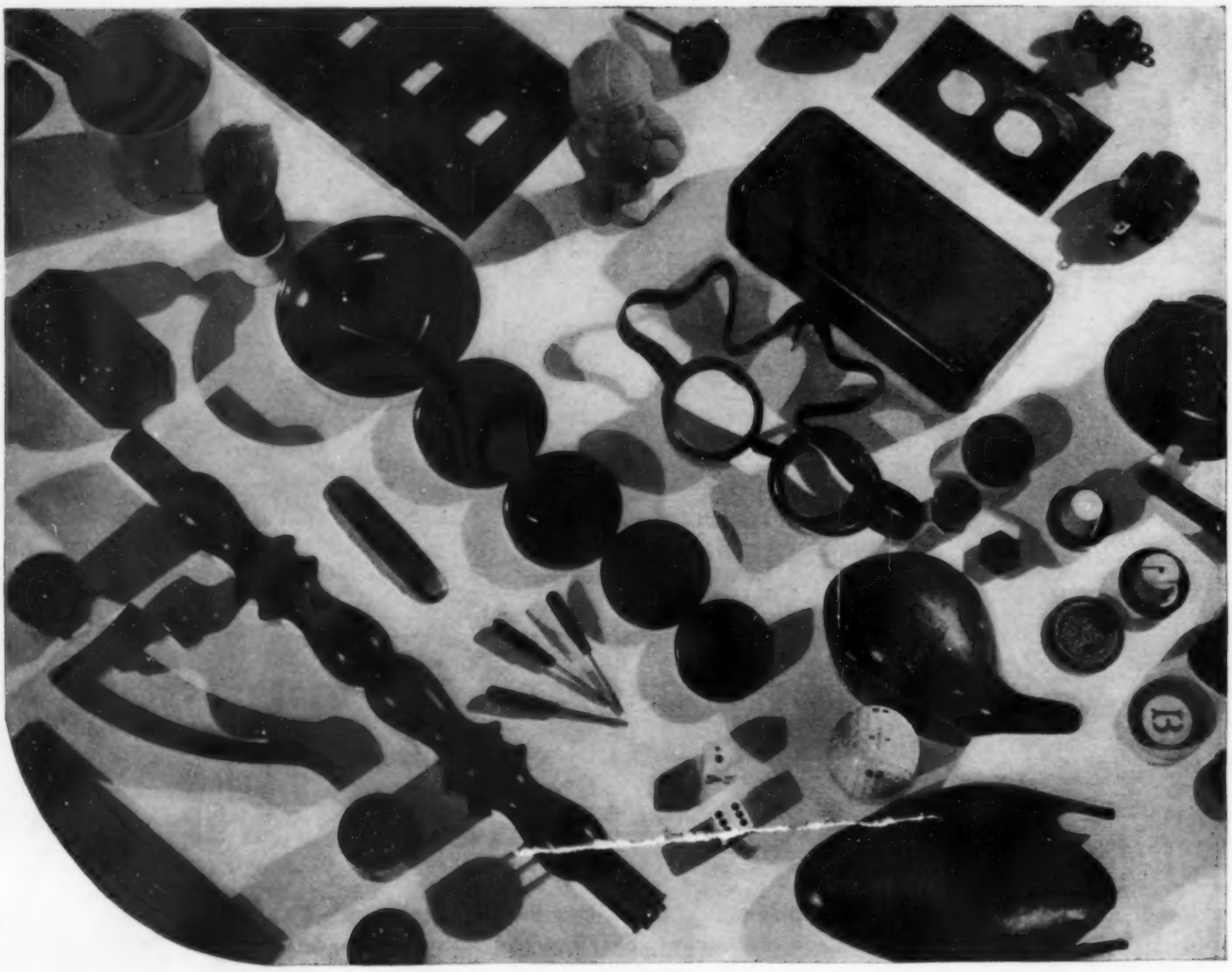
Two bulletins describing the application and fabrication of Lukens Nickel-Clad Steel are available. Copies will be sent promptly on request.

LUKENS NICKEL-CLAD STEEL



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▼ ALPHABETICAL INDEX TO ADVERTISERS ▼

This index is published as a convenience to the reader. Every care is taken to make it accurate, but *Chemical & Metallurgical Engineering* assumes no responsibility for errors or omissions.

	Page
Alsop Engineering Corp.	44
American Air Filter Co.	13
American Instrument Co.	69
American Tool & Machine Co.	21
Babcock & Wilcox Co.	65
Bakelite Corp.	18
Baker & Co., Inc., Platinum Works	28
Baldwin-Southwark Corp.	74
Bemis Bros. Bag Co.	23
Bethlehem Foundry & Machine Co.	58
Bethlehem Steel Co.	31
Blaw-Knox Co.	37
Bristol Co., The	Back Cover
Buffalo Forge Co.	60
Buffalo Foundry & Machine Co.	56
Buffalo Pumps, Inc.	64
Carbide & Carbon Chemicals Corp.	22
Carnegie Steel Co.	1n
Century Electric Co.	48
Chemical Construction Corp.	61
Chemical & Metallurgical Engineering	34-35
Cole Mfg. Co., R. D.	32
Commercial Solvents Corp.	7
Connersville Blower Co.	54
Day Co., J. H.	72
Devine Manufacturing Co., J. P.	59
Dorr Company	53
Du Pont De Nemeurs Co.	27
Duriron Company, The	10
Earle Gear & Machine Co.	54
Edge Moor Iron Co.	39
Electro Metallurgical Sales Corp.	29
Exolon Co., The	63
Fuller Co.	6
Fulton Sylphon Co.	36
General Electric Co.	4, 38
Grasselli Chemical Co.	25
Greene, Tweed & Co.	31
Hardinge Co., Inc.	26
Harrisburg Pipe & Pipe Bending Co.	49
Haynes Stellite Co.	12
Hedges-Walsh-Weidner Co.	36
Hoskins Manufacturing Co.	52
Illinois Steel Co.	16
International Carbonic Engineering Co.	69
Johns-Manville Co.	14
Kent Mill Co.	49
Kimble Glass Co.	15
Link-Belt Co.	9
Liquid Carbonic Corp.	26
Louisville Drying Mchry. Co.	8
Lukens Steel Co.	73
Lunkenheimer Co.	43
McDanel Refractory Porcelain Co.	36
McGraw-Hill Book Co.	32-62
McGraw-Hill Publishing Co.	66-67
Marion Malleable Iron Works	50
Mathieson Alkali Works	3rd Cover
Midvale Co.	30
Mixing Equipment Co., Inc.	62
Monarch Mfg. Co.	69
Morris Machine Works	44
Nash Engineering Co.	40
National Carbon Co.	2nd Cover
National Filter Cloth & Weaving Co.	72
National Tube Co.	42
Newark Wire Cloth Co.	60
Nichols Engineering & Research Corp.	32-59
North American Car Corp.	60
Pacific Foundry Co., Ltd.	32-44
Pfaudler Co.	5
Philadelphia Drying Machinery Co.	36
Philadelphia Gear Works	64
Philadelphia Quartz Co.	24
Pressed Steel Tank Co.	45
Proctor & Schwartz, Inc.	50
Professional Directory	68-69
Pure Oil Company	17
Raymond Bros. Impact Pulv. Co.	55
Republic Steel Co.	33
Robinson Mfg. Co.	46
Roots-Connersville-Wilbraham	54
Sargent's Sons Corp., C. G.	69
Searchlight Section	70-71
Separations Engineering Corp.	63
Service Section	69
Sharples Solvents Co.	11
Sheldon Co., E. H.	64
Shepard-Niles Crane & Hoist Corp.	57
Shriver & Co., T.	47
Solvay Sales Co.	26
Sperry & Co., D. R.	75
Sprout-Waldron Co.	54
Swenson Evaporator Co.	51
Taber Pump Co.	44
Texas Gulf Sulphur Co.	24
Tolhurst Machine Works	76
Turbo-Mixer Corp.	41
U. S. Industrial Alcohol Co.,	Insert 19-20
U. S. Industrial Chemical Co.,	Insert 19-20
U. S. Stoneware Co.	62
Watson-Stillman Co.	50
Western Precipitation	23
Yarnall-Waring Co.	41

DIRECTORY OF ENGINEERS 68-69

SEARCHLIGHT SECTION

Classified Advertising

Classification	Page
BOOKS	70
BUSINESS OPPORTUNITIES	70
EDUCATIONAL	70
EMPLOYMENT SERVICE	70
POSITIONS VACANT	70
POSITIONS WANTED	70
WANTED TO PURCHASE	71
USED & SURPLUS EQUIPMENT	
Consolidated Products Co., Inc.	71
Kehoe Mchry. Co., Robt. P.	70
Loeb Equipment Supply Co.	71
Machinery & Equip. Co., Inc.	71
Miller, I.	71
Stein-Brill Corp.	71

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Does your product have to be filtered while hot? Is temperature control important? Then a Sperry Press like the one illustrated, steam heated, is the one for your purpose.

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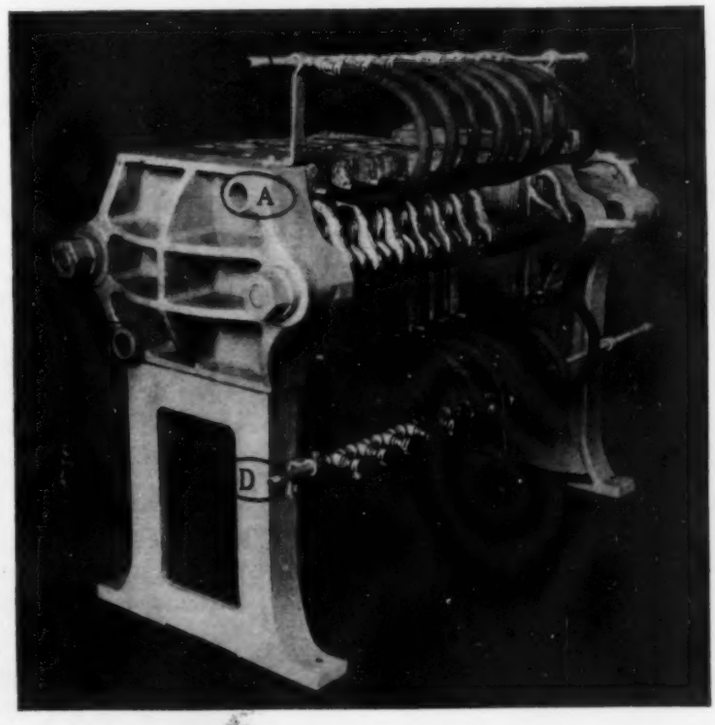

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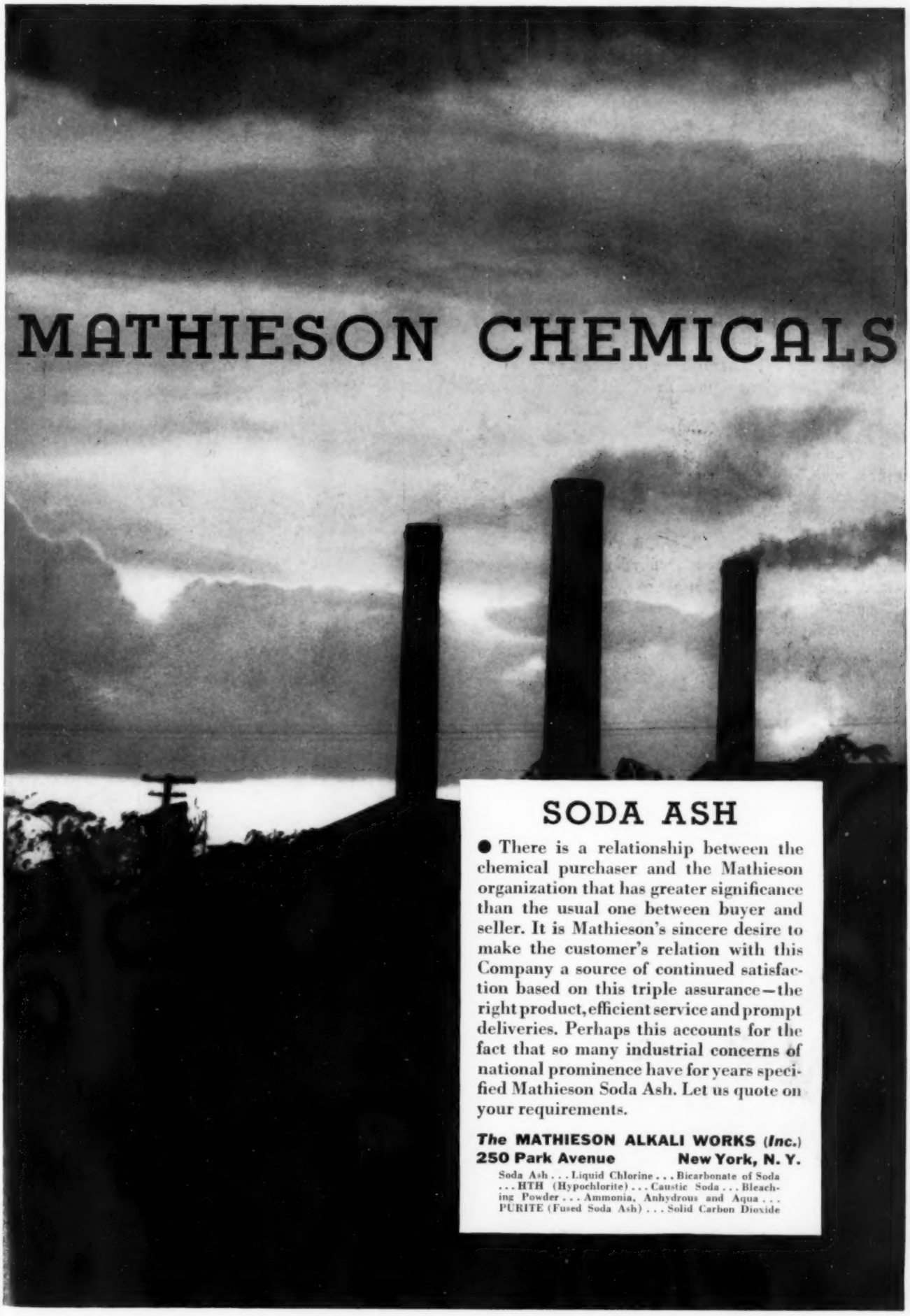
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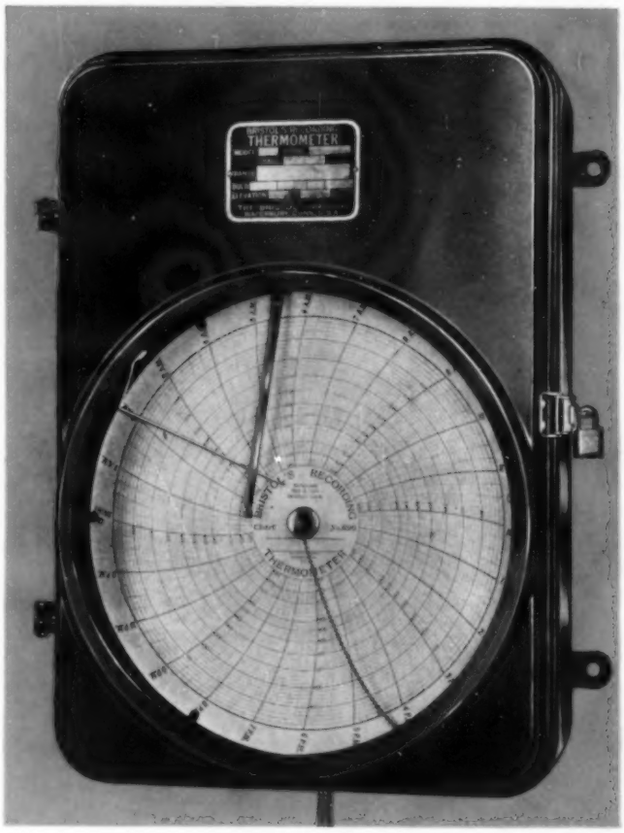

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Ceramics			X	X	X
Chemicals	X	X	X	X	X
Coke		X	X	X	X
Drugs, Cosmetics	X	X	X	X	X
Explosives	X		X	X	X
Fertilizers	X			X	X
Glass				X	
Glue, Adhesives		X	X	X	X
Leather	X			X	X
Lime, Cement				X	

INDUSTRY \ PROCESS	Chemical Reaction	Evaporation and Distillation	Heat Transfer	Drying	Process Steam Generating
Manufactured Gas		X	X	X	X
Oils, Greases	X	X	X		X
Paints, Varnish				X	X
Paper, Pulp	X	X		X	X
Petroleum Refining	X	X	X		X
Rayon	X	X	X	X	X
Rubber	X			X	X
Soap	X	X	X	X	X
Sugar	X	X	X	X	X
Other Industries	X	X	X	X	X